Lumbosacral Transitional Vertebrae and Its Prevalence in the Australian Population

Heath D. French1  Arjuna J. Somasundaram2  Nathan R. Schaefer2  Richard W. Laherty3

1 Department of Neurosurgery, Sir Charles Gairdner Hospital, Perth, Western Australia, Australia
2 Department of Radiology, Gold Coast Hospital, Gold Coast, Queensland, Australia
3 Department of Neurosurgery, Princess Alexandra Hospital, Brisbane, Queensland, Australia

Address for correspondence Heath D. French, MBBS, H102/200 Pacific Highway, Crows Nest, NSW 2065, Australia (e-mail: heathfrench84@gmail.com).

Abstract

Study Design  Retrospective cohort study.
Objective  Lumbosacral transitional vertebrae (LSTV) are a common congenital anomaly, and they can be accurately identified on anteroposterior (AP) radiographs of the lumbosacral spine. This study attempts to determine the prevalence of this congenital anomaly and to increase awareness among all clinicians to reduce the risk of surgical and procedural errors in patients with LSTV.
Methods  A retrospective review of 5,941 AP and lateral lumbar radiographs was performed. Transitional vertebrae were identified and categorized under the Castellvi classification.
Results  The prevalence of LSTV in the study population was 9.9%. Lumbarized S1 and sacralized L5 were seen in 5.8 and 4.1% of patients, respectively.
Conclusion  LSTV are a common normal variant and can be a factor in spinal surgery at incorrect levels. It is essential that all clinicians are aware of this common congenital anomaly.

Keywords  lumbosacral  transitional vertebrae  spinal surgery  lumbarization  sacralization

Introduction

There are normal anatomical variants at the L5–S1 vertebral level,1 commonly termed lumbosacral transitional vertebrae (LSTV).2,3 LSTV includes both lumbarization of the most superior sacral segment and sacralization of the lowest lumbar segment.3 Lumbarization of the S1 vertebra includes features such as anomalous articulation, well-formed lumbar type facet joints, a more squared appearance of the vertebrae, and a well-formed, full-sized disk. Sacralization of the L5 vertebrae is characterized by broadened elongated transverse processes to complete fusion to the sacrum.4,5 In the majority of cases, transition is incomplete or unilateral.6

Castellvi et al devised a system to classify varieties of LSTV by using a set of distinguishing morphologic characteristics.5 This system categorizes LSTV into one of four groups: type I, dysplastic transverse process; type II, incomplete lumbarization/sacralization with a unilateral or bilateral pseudarthrosis; type III, complete lumbarization/sacralization; and type IV, mixed. If the morphology differs between the right and the left side, the transition is designated to the side that has the higher type numerically (►Figs. 1 and 2).

There is currently no standardized method established for identifying LSTV.7 Most authors agree LSTV are best seen on anteroposterior (AP) radiographs, although some go further to advocate a Ferguson view (angled cranially at 30 degrees).4,7–10 A newer method for accurate LSTV identification involves using magnetic resonance imaging (MRI) to locate the iliolumbar ligaments that are thought to arise exclusively from the L5 transverse processes, as this identifies the vertebral level consistently. However, this method is not as accurate in patients with anomalies at the thoracolumbar junction.4,7 Some authors advocate views of the entire spine to properly distinguish between hypoplastic ribs from lumbar transverse processes and to identify the presence of thoracolumbar transitional vertebrae.1,4
Methods

A retrospective review of 5,941 AP and lateral lumbar X-rays was performed. This was achieved by searching the Princess Alexandra Hospital imaging database AGFA Impax version 5.2. Our search was conducted between October 19, 2010, and March 25, 2012. Patients were imaged for a variety of reasons including post–spinal fusion, vertebral fractures, back pain, radicular pain, and orthopedic and neurosurgical preoperative and postoperative scans. Of the 5,941 images reviewed, 512 patients were excluded because of poor image quality, inadequate exposure of the lumbar spine, or inability to identify transitional vertebrae due to instrumentation or abdominal contents.

We identified transitional vertebrae by counting down from the last thoracic vertebra on the AP X-rays, then if necessary looking at the lateral view for confirmation. If hypoplastic ribs were identified, the vertebra immediately beneath would be designated as L1. Castellvi types II, III, and IV were included as transitional states. Type I LSTV were excluded as they lack clinical and surgical significance.5

Data were recorded as type II to IV. All suspected LSTV were jointly reviewed by three researchers, and a consensus was reached on the classification. Data were deidentified and collated using standardized Microsoft Excel (Microsoft Corp., Redmond, Washington, United States) spreadsheets and analyzed using descriptive statistics.

Results

Of the 5,429 lumbar radiographs, 540 were identified as having LSTV, giving a prevalence of 9.9%. Lumbarized S1 and sacralized L5 had a prevalence of 5.8% and 4.1%, respectively (Table 1).

The reporting radiologist identified 30.4% of the cases of LSTV. In 1% of cases, lumbarization of S1 was reported when there was sacralization of L5. In 0.8% of cases, sacralization of L5 was reported when there was lumbarization of S1.

Discussion

Prevalence

To our knowledge, this is the first study to show the prevalence of LSTV in Australia and the largest sample size of LSTV in the world. Nardo et al examined 4,636 radiographs and found the prevalence of LSTV was 18.1%,13 and Tini et al...
studied 4,000 radiographs and found a prevalence of 6.7%.9
Our results fall between these two studies and are similar to
the prevalences reported in other studies.2–4,6,12–20 The
reported prevalence of LSTV in the literature varies and has
ranged from 4 to 36% since it was first reported in
1977.2–4,6,12–20 This wide variation is likely due to differences
in individual diagnostic and classification criteria, observer
error, imaging techniques, and confounding factors of the
population being studied.6

When comparing these transitional states individually,
sacralization of the fifth lumbar vertebrae is more common
than lumbarization of the first sacral segment.5 Sacralized L5
has a reported prevalence of 1.7 to 14%, whereas lumbarized
S1 has a reported prevalence of 3 to 7%.6,7,14,20–26 However,
three of these studies show lumbarization to be more com-
mon than sacralization.20,22,25 which is consistent with our
findings. The prevalence of lumbarization and sacralization in
our study population was 5.3% and 3.8%, respectively. It is
important to note that type I LSTV vertebrae with broad
transverse processes were not counted as transitional in our
study. This may have decreased our recorded prevalence of
sacralized transitional states.

Surgical Errors
Spinal surgeons regularly operate at the L5–S1 junction.27
Patients with LSTV pose an issue for spinal surgeons
because inconsistencies exist between imaging and patient
symptoms.3,4

Errors in numeric identification of the vertebrae have been
reported to cause spinal surgery at incorrect levels on nu-
merous occasions, and the incidence of this is undoubtedly
higher in patients with LSTV.5,28 To identify patients with
LSTV, it is imperative that spinal surgeons order plain lumbar
X-rays prior to surgery. Surgical errors are more likely to
occur when spinal MRIs are reviewed without accompanying
conventional radiographs.29

Although disk surgery performed at the wrong spinal level
is uncommon, an error can have significant consequences for
the patient.2,30 In patients with cauda equina syndrome or
foot drop secondary to spinal canal stenosis or nerve root
compression, surgery on the correct spinal level prevents
serious morbidity.30 Often patients who have spinal opera-
ations at the wrong level must undergo a second operation or
they will remain symptomatic. This has obvious detriments
for both hospital and patient in terms of monetary cost,
ongoing burden of disease, and the potential for postopera-
tive complications. It is critical that spinal surgeons are aware
of LSTV to reduce the risk of surgical and procedural
errors.3,4,28

Table 1 Breakdown of different types of lumbosacral transitional vertebrae

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumbarized S1</td>
<td>315 (5.8%)</td>
<td>80 (1.5%)</td>
<td>186 (3.4%)</td>
<td>49 (0.9%)</td>
</tr>
<tr>
<td>Sacralized L5</td>
<td>225 (4.1%)</td>
<td>144 (2.7%)</td>
<td>73 (1.3%)</td>
<td>8 (0.1%)</td>
</tr>
</tbody>
</table>

Reporting of LSTV
The low number of LSTV reported may be due to observer
error or insufficient awareness of transitional lumbosacral
anatomy. Consistently reporting LSTV can be difficult for
radiologists when different investigations are done at differ-
ent locations and previous imaging is not available for com-
parison. It is not essential for radiologists to classify LSTV
using the Castelvi classification system, but they should be
able to identify a lumbosacral transitional state and describe
the anatomy accurately and consistently.

Ultimately, however, the responsibility lies with the spinal
surgeon to perform surgery at the correct level, and they need
to be confident that they can identify the correct spinal level
with preoperative and intraoperative imaging. Where there is
confusion, the surgeon should confer with the radiologist to
ensure that there is consistency in relation to labeling and
documentation.3 Further investigation and potential inter-
vention in the form of nerve root blocks may be of value to
confirm that the correct level is operated on.

LSTV and Back Pain
The association between LSTV and back pain has been well
documented.31 It was first described by Bertolotti in 191732
however, it stills remains a contentious point nearly a century
later.15,16,18,31–36 There are studies both supporting and
disputing the association between LSTV and back pain.4
Further research is needed to bring consensus on this subject.

Potential Limitations
This study did not analyze imaging that was performed on
asymptomatic individuals, so there is a potential selection
bias in the study population. It is possible that the prevalence
of LSTV in the study population is higher than that in the
general population for this reason. However, given that the
patients in this study were imaged for several reasons not
limited to back pain, the effect on the results should be minor.
Observer error when reading films and the differences in
diagnostic criteria between researchers and other studies are
other limitations to this study. Three researchers indepen-
dently reviewed all X-rays suspected of having LSTV to reduce
these errors.

Conclusion
The prevalence of LSTV in this study sample was 9.9%. LSTV
are a common normal variant in the population, which can
have significant implications for spinal surgery. It is essential
that spinal surgeons and radiologists are aware of LSTV and
are highly vigilant for this common anatomical variant.
References