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# Lumbosacral transitional vertebra in a population-based study of 5860 individuals: Prevalence and relationship to low back pain

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ABSTRACT

*Purpose:* To investigate the prevalence of lumbosacral transitional vertebra (LSTV) within the Chinese Han population, and to determine whether LSTV correlates with low back pain (LBP) and gluteal pain.
*Materials and methods:* Typical standing pelvic radiographs were obtained for 5860 volunteers between 18 to 60 years of age. The lumbosacral region of each spine was evaluated to identify LSTV, which was classified into types I, II, III, and IV based on Castellvi's method. Histories of low back symptoms were obtained using a questionnaire. The association of different subtypes of LSTV with LBP and gluteal pain was explored.
*Results:* LSTV was found in 15.8% (928 of 5860) of our study population. Of the 928 individuals with LSTV, 44.8% were type I (dysplastic transverse process with height >19 mm), 43.2% were type II (pseudoarticulation), 7.2% were type III (fusion), and 4.8% were type IV (a unilateral type II transition with a type III fusion on the contralateral side). Type II LSTV were closely associated with LBP and gluteal pain, with respective odds ratios (ORs) of 2.56 (95% CI: 2.17–3.89) and 5.38 (95% CI: 4.29–8.43). Similarly, types IV LSTV also demonstrated a significant correlation with LBP and gluteal pain, with respective ORs of 4.28 (95% CI: 3.21–6.35) and 6.82 (95% CI: 5.17–16.59).
*Conclusions:* In this population-based study, the prevalence of LSTV was 15.8%, with type I being the most common. Importantly, LSTV types II and IV were significantly associated with LBP and gluteal pain.


## 1. Introduction

Lumbosacral transitional vertebra (LSTV), a common congenital anomaly first observed by Bertolotti in 1917, is defined as a total or partial unilateral or bilateral fusion of the enlarged transverse process of the lowest lumbar vertebra to the sacrum [1,2]. Abnormal biomechanics associated with asymmetric transitional vertebra has been suggested to cause pain on the side of the anomalous articulation [3,4] or on the opposite side [5]. However, whether such an anatomical variation produces low back pain (LBP) and/or sciatica has been a subject of great debate. Some authors believe that the LSTV could cause symptoms of back pain and/or sciatica [3,6,7], whereas others claim that this abnormal vertebra does not affect their incidence [4]. Therefore, further studies focusing on the relationship between LSTV and LBP are needed to reach a conclusion. To date, there are only two large-scale studies of LSTV in the adult population [8,9]. However, these two studies were not carried out in the general population, and therefore may not reflect the true prevalence of LSTV.

A systematic study of LSTV in the lumbosacral region among the general population can provide fundamental epidemiologic insights regarding LSTV and an important reference for clinical observations. The primary purpose of the present study was to identify the prevalence of LSTV using a large population-based sample. Additionally, we also investigated the association of the different subtypes of LSTV with LBP and gluteal pain.

## 2. Materials and methods

### 2.1. Subjects

The local ethics committee approved the study and informed consent was obtained. The maximum number of patients and the time span of study inclusion were defined in our ethic committee proposal. We performed a power analysis using Quanto software. The results showed a power value of 0.89 using a prevalence of LSTV in other populations of 4% [3,8]. Additionally, the number of patients was calculated. Following this, a prospective study was performed. Volunteers of Chinese Han origin, aged 18–60 years,

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were recruited randomly from the local communities by open invitation, newspaper advertisements, e-mails, and posters (which were circulated in different universities) between January 2008 and January 2013. Importantly, open invitations were randomly sent to the local communities. All volunteers answered a set of questionnaires regarding their back pain history and underwent radiographic examination of the lumbar spine in our hospital. The questions concerning LBP were as follows [4]: have you ever had LBP; during the past 4 years; during the previous 12 months? What type of LBP have you had: lumbago (meaning a sudden attack of LBP); buttock pain; other LBP? All types of LBP, local LBP, and radiating pain during the past 4 years and during the past 12 months were used as outcome measures in the analysis. The pelvic radiographs were independently screened by four radiologists for image quality (i.e., the ability to assess the relationship between the sacral ala and the lumbar transverse process), postsurgical changes obscuring the transitional anatomy, and the presence of LSTV. Out of 6239 radiographs, 379 were considered to be of poor quality and excluded from the study. Finally, a total of 5860 subjects, including 3217 males and 2643 females, were enrolled in the current study.

### 2.2. Imaging technique and analysis

Standardised standing pelvic radiographs were carried out using a foot-positioning mat with the toes internally rotated at 5°, and the X-ray beam was positioned approximately 7 cm above the pubic symphysis [8]. All individuals were examined at the same hospital. All images were obtained with identical equipment (Philips Bucky Diagnost) and exposure settings (80–90 kV and 20–30 mA).

All images were reviewed on PACS by four different radiologists (T.M., 16 years of experience; Y.X.F., 12 years of experience; Y.S.W., 8 years of experience; M.Y.M., 11 years of experience). The four different radiologists were on-duty staff radiologists. Radiographs were classified according to the presence of LSTV. The presence of an LSTV was determined manually by assessing the craniocaudal width of the transverse process, with a threshold of greater than 19 mm, or by the presence of articulation or complete fusion of the transverse process with the sacrum. All discrepancies were settled by a fifth radiologist (Z.B., 38 years of experience). Subjects with LSTV were graded according to the Castellvi classification of LSTV [2]. Furthermore, Table 1 demonstrates the main characteristics of the Castellvi classification. Based on the Castellvi classification, we classified the subjects with LSTV (Fig. 1).

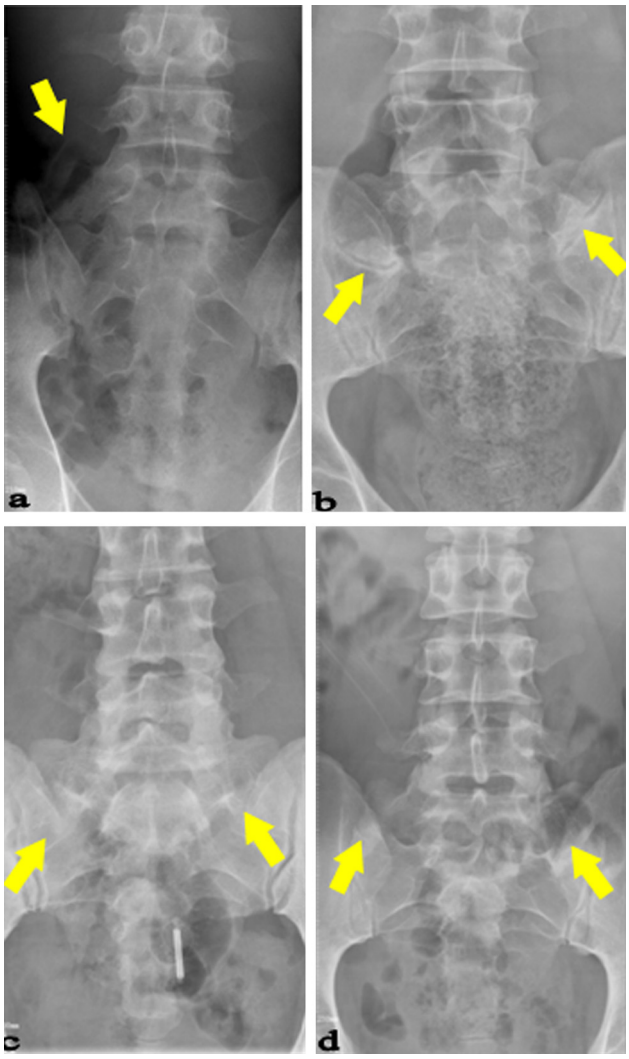


**Fig. 1.** Illustration demonstrating the Castellvi classification of LSTVs. Type I: dysplastic enlarged transverse process; (b) type II: pseudoarticulation of the transverse process with the sacrum with increased sclerosis; (c) type III: fusion with the sacrum; (d) type IV: unilateral LSTV type II with type III fusion on the contralateral side.

### 2.3. Reproducibility analysis

Images were reviewed again by the same radiologists who conducted the first analysis. When examining the interobserver and intraobserver agreement, *k* and weighted *k* coefficients were computed for categorical variables. Intraobserver reproducibility was obtained by using 2000 randomly selected radiographs that were independently analysed by two radiologists on two separate occasions. Cohen *k* values were calculated to assess intraobserver and interobserver agreement of the radiographic classification according to the Castellvi classification.

**Table 1**
Castellvi classification of LSTV [2].

| Castellvi type | Definition |
|---|---|
| Type I: dysplastic transverse process | Unilateral (A) or bilateral (B) dysplastic transverse process with height >19 mm |
| Type II: incomplete lumbarization/sacralization | Enlarged transverse process with unilateral (A) or bilateral (B) pseudoarthrosis with the adjacent sacral ala |
| Type III: complete lumbarization/sacralization | Enlarged transverse process, which has a unilateral (A) or bilateral (B) complete fusion with the adjacent sacral ala |
| Type IV: mixed | Type II on one side and type III on the other side |

*Note*:
Type I A: unilateral dysplastic transverse process with height >19 mm.
Type I B: bilateral dysplastic transverse process with height >19 mm.
Type II A: enlarged transverse process with unilateral pseudoarthrosis with the adjacent sacral ala.
Type II B: enlarged transverse process with bilateral pseudoarthrosis with the adjacent sacral ala.
Type III A: unilateral lumbarisation/sacralisation with complete osseous fusion of the transverse processes to the sacrum.
Type III B: bilateral lumbarisation/sacralisation with complete osseous fusion of the transverse processes to the sacrum.