 Acta Chir Orthop Traumatol Cech. 90, 2023, No. 5, p. 353–357
DOI: 10.55095/ACHOT2023/043

Monozygotic Twins with Legg-Calvé-Perthes Disease and with Non-Identical Lumbosacral Malformation: a Case Report and Literature Review

Jednovaječná dvojčata s morbus Legg-Calvé-Perthes a neidentickou lumbosakrální malformací: kazuistika a přehled literatury

M. HRUBÁ[1], P. BÁRTA[2], V. DŽUPA[3], M. KRBEC[3]

[1] Department of Trauma and Plastic Surgery, Hospital České Budějovice, Czech Republic
[2] Department of Surgery, Hospital České Budějovice, Czech Republic
[3] Department of Orthopaedics and Traumatology, Third Faculty of Medicine, Charles University, and University Hospital Královské Vinohrady, Prague, Czech Republic

SUMMARY

The authors present the cases of monozygotic male twins with right-sided Legg-Calvé-Perthes disease (LCPD) with different formation of the lumbosacral junction. This is likely the first description of a lumbosacral junction formation disorder associated with identical twins who were both treated for LCPD as children.

The disease began at 6 and 9 years of age and during treatment as well as in adulthood significantly different bone formation of the lumbosacral transitional vertebra, was observed in both brothers. Twin A has a unilateral right-sided fusion of the enlarged L5 transverse process with the ipsilateral sacral ala, twin B has a complete sacralization of the fifth lumbar vertebra. The LCPD treatment outcomes in the twins were consistent with the results from large studies, i.e., age at the time of LCPD onset is the main factor influencing the prognosis, however the morphological difference in the transitional vertebrae in these monozygotic twins was significantly.

Key words: lumbosacral transitional vertebra, lumbosacral junction formation, sacralization of lumbar vertebra, megatransverse of vertebra L5.

This work was supported by the Specific student research program of Charles University.

INTRODUCTION

Legg-Calvé-Perthes disease (LCPD) is an idiopathic disease of the hip joint that occurs in childhood manifesting as avascular necrosis of the proximal femoral epiphysis (15), which can lead to the collapse of the femoral head. Successful treatment can result in both an anatomically and functionally normal joint, while less successful treatment can lead to variously severe deformities that can predispose to the early development of arthrosis (15, 19). The disease occurs more in young males, most often between the ages of 5 and 8 years, although the ages from 2 to 15 years have been described (12, 17, 33). The LCPD risk factors include changes in coagulation and anticoagulant proteins (8, 35) and/or low birth weight (23, 37). Studies have not found a higher incidence of LCPD in twins (23, 29). Whether a patient is treated conservatively or operatively depends on the extent of the involvement of the femur head and the age of the patient at the onset of the disease (15). These two parameters also provide an estimate of the prognosis regarding the expected outcome of treatment and future development of degenerative arthritis, with the age limit between clinically and radiologically acceptable and unacceptable results being between 6 and 8 years (15, 19, 36). The aim of this report is to (1) describe the right-sided occurrence of LCPD in monozygotic male twins, which began at different ages, and had unique clinical and radiological results, to treatment, and (2) to draw attention to the finding of non-identical malformation of the skeletal lumbosacral junction in the two brothers.

CASE REPORT

Twin B. In the younger of the siblings, the first clinical signs (non-painful limp) appeared at the age of 6 years and 4 months and the diagnosis was established based on an X-ray image 2 months later. Conservative treatment was started using the "containment" principle, i.e., after managing the pain and restoring hip movement, an Atlanta splint was applied for 6 months. This was followed by a 4-month rehabilitation period, which allowed of restoring the full range of movement to the affected right hip joint and correct the posture and gait.

The initial X-rays were assessed a Catterall stage III and Herring group B (Fig. 1a,b), a femoral head with a Stulberg type II was seen on the 18-month follow-up images (Fig. 1c,d).

During a clinical examination 23 years after initial treatment, the patient did not report any subjective difficulties. He regularly devoted himself to sports (athletics, swimming, gymnastics, cycling). The physical examination found that the length of the limbs was the same; the

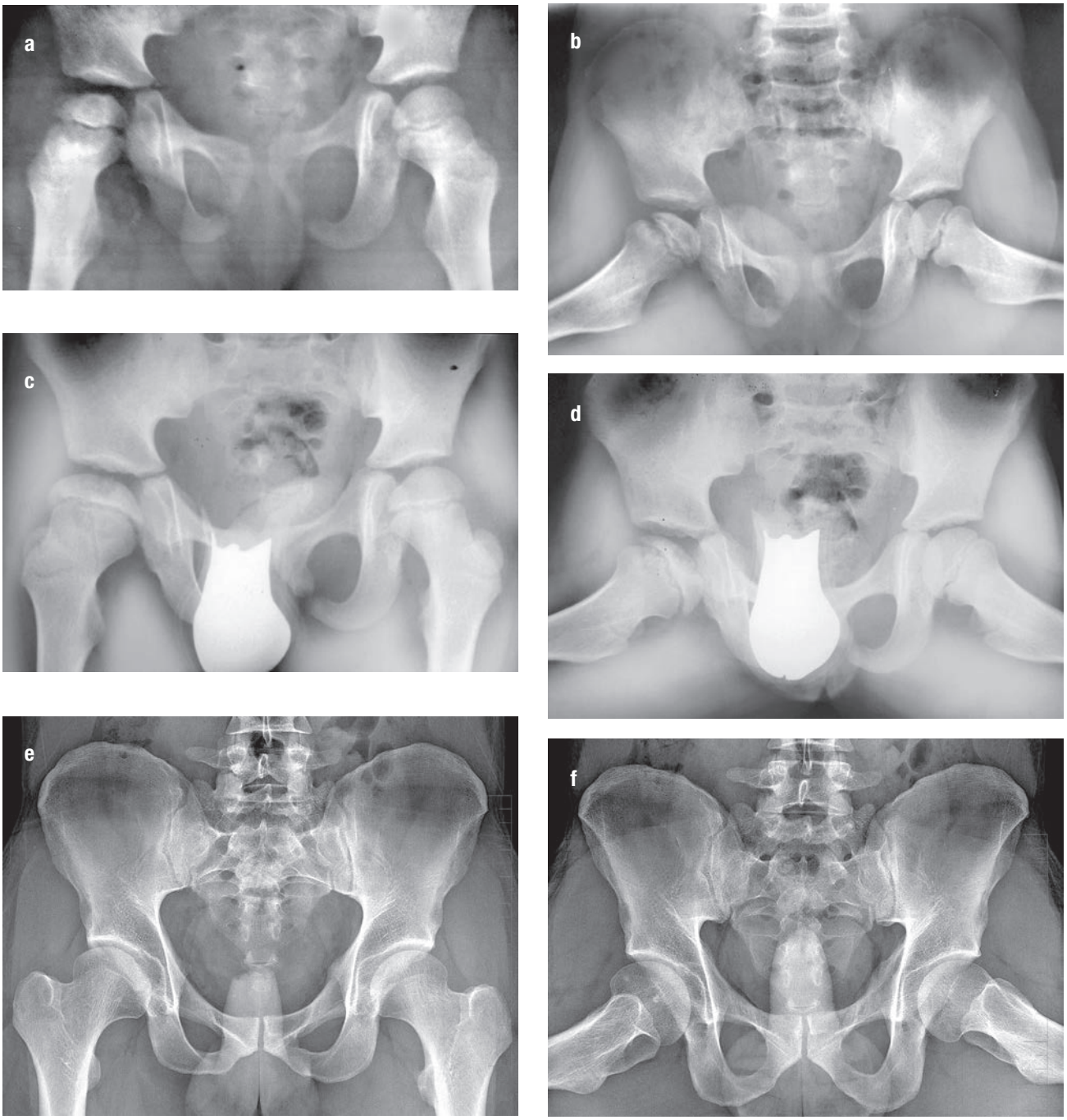

Fig. 1. X-ray documentation of twin B, in whom the disease began at the age of 6 years and 4 months: a, b – anteroposterior and Lauenstein pelvic views at the beginning of a therapy of the right proximal femoral epiphysis; c, d – follow-up images 12 months later; e, f – follow-up images 23 years after treatment, showing a slightly oval right femoral head and complete sacralization of L5.

range of movement of the right hip joint was unrestricted and fully comparable to the movement of the unaffected left hip joint. The only asymmetry was that the right thigh have a smaller circumference (by 2 cm). X-rays showed a congruent joint and a slightly oval femur head that resembled the head of the left femur; however, along its long axis, it was 4 mm longer than to the left side (Fig. 1e,f). As a secondary finding, a complete sacralization of the fifth lumbar vertebra was noted. During a subsequent targeted query, the patient did not mention any subjective difficulties in this area.

Twin A. The older of the brothers was brought in by his parents after completing six months of "non-containment" conservative therapy at another medical facility (crutches), the parents were offer but refused surgical treatment. In twin A, the disease began at 9 years and 9 months. On examination, the patient had limited flexion of 0–110 degrees and pain-free rotation of 10–0–20 degrees. At the time of the follow-up examination 4 years after the onset of the disease, the range of hip joint movement continued to be slightly limited in flexion and rotation compared to the other side; additionally,

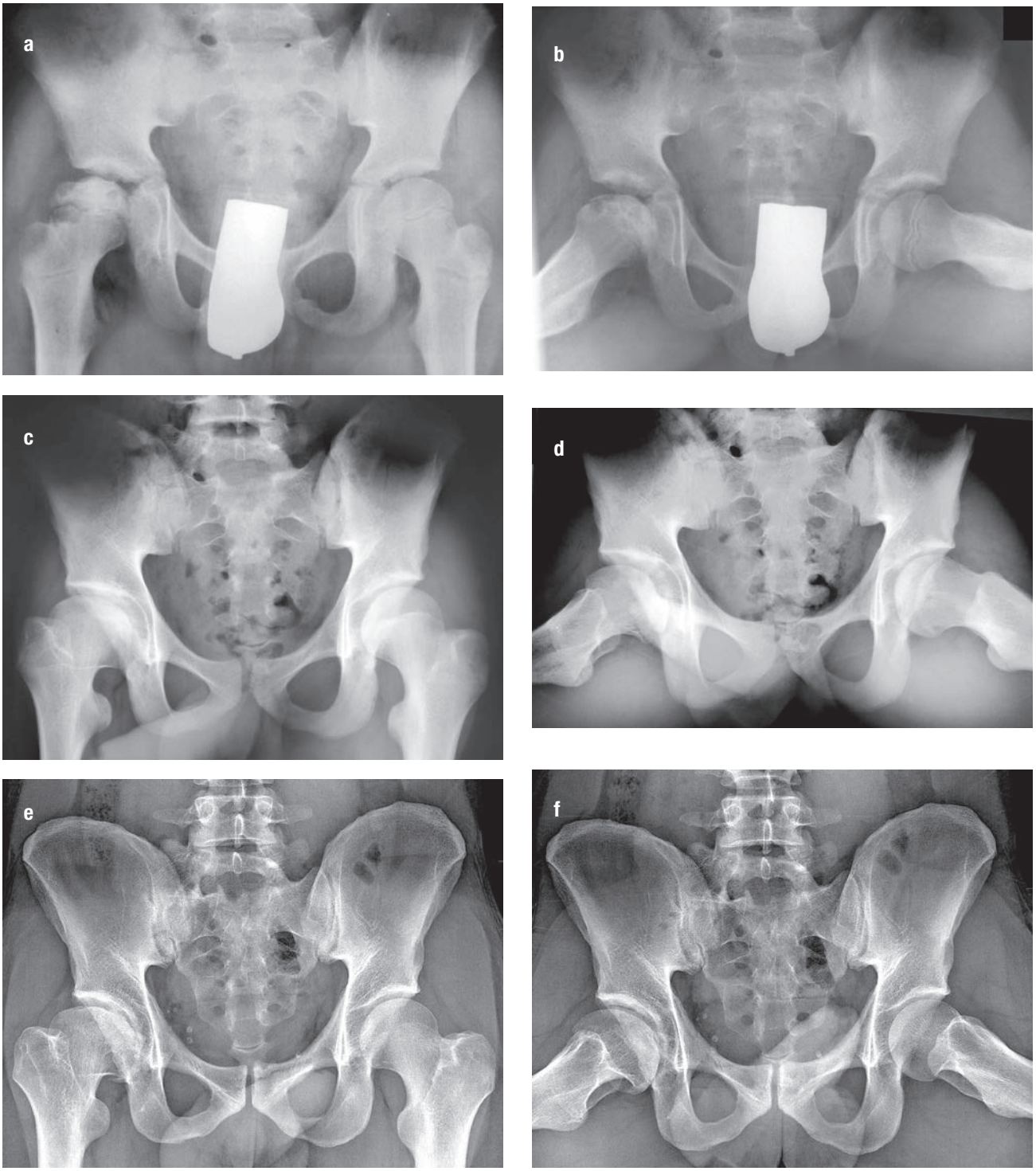

Fig. 2. X-ray documentation of twin A, in whom the disease began at the age of 9 years and 9 months: a, b – anteroposterior and Lauenstein views of the pelvis 6 months after completion of "non-containment" therapy;-c, d – follow-up images 4 years later; e, f – follow-up images 20 years after treatment shows the coxa planovara on the right with an uneven articular surface of the femoral head a smaller size of the right hemipelvis, and the right-sided fusion of megatransverse process L5.

the affected limb was 15 mm shorter than the unaffected limb.

Post-treatment X-rays were similar to that of his brother, i.e., Catterall category III and Herring group B, but with a significant lateral metaphyseal component (Fig. 2a, b). In X-rays taken 4 years after the end of treatment, showed a shortened femoral neck and flattened acetabulum – Stulberg III (Fig. 2c, d). The images also showed a unilateral right-sided fusion of the enlarged L5 transverse process with the ipsilateral sacral ala (Castelvi type IIIa) (5).

During a clinical examination 20 years after the onset of the disease, the older brother failed to mention any subjective difficulties. Like his brother, he was

a participant in the same recreational athletics as his brother. The right lower limb was 12 mm shorter compared to the left, unlike his brother, there was no apparent difference in thigh circumferences. The X-ray image showed a coxa planovara on the right with an uneven head surface up to 2 mm (Fig. 2e, f). As a secondary finding, the entire right hemipelvis was of a smaller size, and a unilateral, right-sided fusion of the enlarged L5 megatransverse process with the right side of the sacrum was evident.

DISCUSSION AND CONCLUSIONS

Our observations are consistent with the findings reported in other studies in that a lower age of disease onset leads to a better prognosis (15, 19, 36). A possible explanation is that in younger children, there is greater potential for the proximal femur to revascularize and regenerate the damaged bone structures, thereby leading to a restoration of the normal shape of the femoral head. In our observations, the twin with the earlier disease onset achieved better x-ray results, keeping in mind that the brother with the later disease onset was not treated according to the principle of „containment," which could have easily played a role and resulted in worse x-ray findings (12, 15).

Detection of LCPD in twins, especially identical twins, is rare, and large studies in these cases suggest a rather low concordance, and thus little or no genetic basis for the disease (23, 29). However, single-egg twins can offer an almost perfect model for evaluating results after treatment initiated at different ages due to the similarity of genetics and environment.

An asymmetric finding of the lumbosacral junction leads to the following questions: (1) What is the developmental basis for the significant differences in the morphology of the spinopelvic junction in monozygotic twins with identical genetics? (2) Did the spinopelvic junction disorder have an etiological link to LCPD?

Our search of the literature failed to find a similar malformation of the lumbosacral junction in identical twins. In studies that evaluated more than 1,000 patients with spinopelvic junction disorders, there was no mention of transitional vertebrae in siblings or monozygotic twins (1–3, 7, 9, 10, 14, 25, 34). However, we must note that most of the work devoted to the occurrence of transitional vertebrae did not primarily follow an epidemiological context but was aimed at assessing the impact of morphological variations on the occurrence of clinical difficulties (16, 22, 27). Our observations of both brothers support the findings of the studies, in that the presence of the transitional vertebrae did not lead to difficulties, although the onset of the transitional vertebrae-related difficulties is often reported after forty years of age (9, 21, 32).

Studies that dealt with LCPD did not report a higher incidence of lumbosacral junction disorders or the presence of transitional vertebrae (13, 26). Therefore, we believe that our study is the first description of two unique lumbosacral junction malformations occurring in identical twins whom experienced LCPD in childhood.

In congenital and developmental defects of the spine, genetic predispositions play a significant role in the etiopathogenesis; the more and more independently the higher the degree of concordance found. Sturm et al. found identical thoracic hemivertebra in monozygotic twins (30). Lembet et al. found congenital malformations of the neural lamina closures in the form of spina bifida in bichoriotic biamniotic twins (20). Similarly, Tang et al. found os odontoideum with symptomatic atlantoaxial dislocation in identical twins aged 24 years, without any traumatic history; as such, it was assumed to have a congenital etiology (31). Mitsuka et al. described a symptomatic case of tethered cord syndrome in identical male twins aged 11 years (24). Chang et al. described monozygotic twins with almost identical congenital kyphoscoliosis caused by formation and segmentation disorders that were etiologically heterogeneous and influenced by genetic, epigenetic, and environmental factors (6).

Sandal et al. described monozygotic twins, one of whom suffered from VACTERL association – in this case, limb malformations (polydactyly), a heart defect, one umbilical artery, bilateral kidney agenesis, the bladder and urethral atresia, and butterfly vertebrae at T9 and T11, which is a relatively rare congenital spine deformity; the second twin was completely healthy (28). According to the authors of the study, this shows the strong influence of epigenetic and environmental factors on formation and segmentation disorders. Similar mechanisms can be traced to other developmental disorders of the spine. Graat et al. described the development of Scheuermann's kyphosis in two identical male monozygotic twins (11). Kaila et al. described the rare, but similar development of a thoracic scoliotic curve in monozygotic twins after intercostal thoracotomy, while others undergoing the same treatment did not develop the deformity afterward (18). By contrast, Burwell et al. described dissimilar development of idiopathic scoliosis in monozygotic twins, which they attributed to unknown environmental factors (including intrauterine) and epigenetic differences (4).

These examples indicate that the main causes of congenital spinal deformity are genetic, which can, however, be influenced by the action of epigenetic factors and of unknown environmental factors, including intrauterine factors that can modify phenotypic manifestations in monozygotic twins.

While the after-treatment results of the affected proximal femoral epiphyses were consistent with the conclusions of large studies, the difference in the lumbosacral junction in siblings with identical genetic makeup and very similar environmental factors during growth and adolescence, remain difficult to explain. It is very likely that in the single-egg twins, the secondary finding we describe, i.e., unidentical lumbosacral junction malformation, was a combined formation and segmentation disorder that occurred in the early stage of embryonic develop-

ment (week 3 to 5) having a different phenotypical manifestation in each twin. This difference can potentially be explained by the action of unknown environmental factors (including intrauterine) and epigenetic differentiation, which may be a link between environmental factors and phenotypic presentation.

Authors' contributions

Michaela Hrubá a Petr Bárta contributed equally and shall be considered joint first authors.

References

1. Apaydin M, Uluc ME, Sezgin G. Lumbosacral transitional vertebra in the young men population with low back pain: anatomical considerations and degenerations (transitional vertebra types in the young men population with low back pain). Radiol Med. 2019;124:375–381.
2. Apazidis A, Ricart PA, Diefenbach CM, Spivak JM. The prevalence of transitional vertebrae in the lumbar spine. Spine J. 2011;11:858–862.
3. Barzó P, Vörös E, Bodosi M. [Clinical significance of lumbosacral transitional vertebrae (Bertolotti syndrome)] (Hungarian). Orv Hetil. 1993;134:2537–2540.
4. Burwell RG, Dangerfield PH, Moulton A, Grivas TB. Adolescent idiopathic scoliosis (AIS), environment, exposome and epigenetics: a molecular perspective of postnatal normal spinal growth and the etiopathogenesis of AIS with consideration of a network approach and possible implications for medical therapy. Scoliosis. 2011;6:26; doi:10.1186/1748-7161-6-26.
5. Castellvi AE, Goldstein LA, Chan DP. Lumbosacral transitional vertebrae and their relationship with lumbar extradural defects. Spine. 1984;9:493–495.
6. Chang DG, Yang JH, Lee JH, Kim YH, Kim JH, Suh SW, Ha KY, Suk SI. Congenital kyphoscoliosis in monozygotic twins: ten-year follow-up treated by posterior vertebral column resection (PVCR): a case report. Medicine (Baltimore). 2016;95:e3499; doi:10.1097/MD.0000000000003499.
7. Dzupa V, Slepanek M, Striz M, Krbec M, Chmelova J, Kachlik D, Baca V. Developmental malformations in the area of the lumbosacral transitional vertebrae and sacrum: differences in gender and left/right distribution. Surg Radiol Anat. 2014;36:689–693.
8. Eldridge J, Dilley A, Austin H et al. The role of protein C, protein S, and resistance to activated protein C in Legg-Perthes disease. Pediatrics. 2001;107:1329–1334.
9. Elster AD. Bertolotti´s syndrome revisited: transitional vertebrae of the lumbar spine. Spine. 1989;14:1373–1377.
10. French HD, Somasundaram AJ, Schaefer NR, Laherty RW. Lumbosacral transitional vertebrae and its prevalence in the Australian population. Global Spine J. 2014;4:229–232.
11. Graat HC, van Rhijn LW, Schrander-Stumpel CT, van Ooij A. Classical Scheuermann disease in male monozygotic twins: further support for the genetic etiology hypothesis. Spine (Phila Pa 1976). 2002;27:E485–E487.
12. Grasemann H, Nicolai RD, Patsalis T, Hövel M. The treatment of Legg-Calvé-Pethes disease: to contain or not to contain. Arch Orthop Trauma Surg. 1997;116:50–54.
13. Hailer YD, Hailer NP. Is Legg-Calvé-Perthes disease a local manifestation of a systemic condition? Clin Orthop Relat Res. 2018;476:1055–1064.
14. Hanhivaara J, Määttä JH, Niinimäki J, Nevalainen MT. Lumbosacral transitional vertebrae are associated with lumbar degeneration: retrospective evaluation of 3855 consecutive abdominal CT scans. Eur Radiol. 2020;30:3409–3416.
15. Herring JA, Kim HT, Browne R. Legg-Calvé-Perthes disease – part II: prospective multicenter study of the effect of treatment on outcome. J Bone Jt Surg Am. 2004;86:2121–2134.
16. Jancuska JM, Spivak JM, Bendo JA. A review of symptomatic lumbosacral transitional vertebrae: Bertolotti's syndrome. Int J Spine Surg. 2015;9:42; doi:10.14444/2042.
17. Johansson T, Linblad M, Bladh M, Josefsson A, Sydsjö G. Incidence of Perthes´ disease in children born between 1973 and 1993: a Swedish nationwide cohort study of 2.1 million individuals. Acta Orthop. 2017;88:96–100.
18. Kaila R, Blackman M, Lehovsky J. Scoliosis development in identical twins after intercostal thoracotomy for pulmonary artery sling correction. Ann R Coll Surg Engl. 2006;88:W1–W3.
19. Lecuire F. The long-term outcome of primary osteochondritis of the hip (Legg-Calvé-Perthes´ disease). J Bone Joint Surg Br. 2002;84:636–640.
20. Lembet A, Ugurlu EN, Toprak T, Bastu E. Rare case of spina bifida in both twins with possible genetic basis. J Obstet Gynaecol Res. 2011;37:1755–1758.
21. Luoma K, Vehmas T, Raininko R, Luukkonen R, Riihimäki H. Lumbosacral transitional vertebra: relation to disc degeneration and low back pain. Spine. 2004;29:200–205.
22. Matson DM, MacCormick LM, Sembrano JN, Polly JR DW. Sacral dysmorphism and lumbosacral transitional vertebrae (LSTV): review. Int J Spine Surg. 2020;14(Suppl 1):14–19.
23. Metcalfe D, Van Dijck S, Parsons N, Christensen K, Perry DC. A twin study of Perthes disease. Pediatrics. 2016;137:e20153542; doi.org/10.1542/peds.2015-3542.
24. Mitsuka K, Horikoshi T, Watanabe A, Kinouchi H. Tethered cord syndrome in identical twins. Acta Neurochir (Wien). 2009;151:85–88.
25. Otani K, Konno S, Kikuchi S. Lumbosacral transitional vertebrae and nerve-root symptoms. J Bone Joint Surg Br. 2001;83:1137–1140.
26. Pharoah POD. Twins and locomotor disorder in children. J Bone Joint Surg Br. 2006;88:295–297.
27. Ravikanth R, Majumdar P. Bertolotti´s syndrome in low-backache population: classification and imaging findings. Ci Ji Yi Xue Za Zhi. 2019;31:90–99.
28. Sandal G, Aslan N, Duman L, Ormeci AR. VACTERL association with a rare vertebral anomaly (butterfly vertebra) in a case of monochorionic twin. Genet Couns. 2014;25:231–235.
29. Sirvent N, Fisher F, el Hayek T, Appert A, Giudicelli H, Griffet J. Absence of congenital prethrombotic disorders in children with Legg-Perthes disease. J Pediatr Orthop B. 2000;9:24–27.
30. Sturm PF, Chung R, Bomze SR. Hemivertebra in monozygotic twins. Spine (Phila Pa 1976). 2001;26:1389–1391.
31. Tang X, Tan M, Yi P, Yang F, Hao Q. Atlantoaxial dislocation and os odontoideum in two identical twins: perspectives on etiology. Eur Spine J. 2018;27(Suppl 3):259–263.
32. Taskaynatan MA, Izci Y, Ozgul A, Hazneci B, Dursun H, Kalyon TA. Clinical significance of congenital lumbosacral malformations in young male population with prolonged low back pain. Spine. 2005;30:E210–E213.
33. Terjesen T, Wiig O, Svenningse S. The natural history of Perthes´ disease: risk factors in 212 patients followed for 5 years. Acta Orthop. 2010;81:708–714.
34. Tins BJ, Balain B. Incidence of numerical variants and transitional lumbosacral vertebrae on whole-spine MRI. Insights Imaging. 2016;7:199–203.
35. Vosmaer A, Pereira R, Koenderman JS, Rosendaal FR, Cannegieter SC. Coagulation abnormalities in Legg-Calvé-Perthes Disease. J Bone Joint Surg Am. 2010;92:121–128.
36. Wiig O, Terjesen T, Svenningsen S. Prognostic factors and outcome of treatment in Perthes´s disease. J Bone Joint Surg Br. 2008;90:1364–1371.
37. Wiig O, Terjesen T, Svenningsen S, Lie SA. The epidemiology and aetiology of Perthes´ disease in Norway: a nationwide study of 425 patients. J Bone Joint Surg Br. 2006;88:1217–1223.

Corresponding author:
Valér Džupa
Department of Orthopaedics and Traumatology Third Faculty of Medicine, Charles University, and University Hospital Královské Vinohrady
Šrobárova 50, CZ-100 34 Prague
E-mail: valer.dzupa@fnkv.cz