

The limping nuns. Two cases of hip dislocation in a medieval female monastery

Paola Saccheri, Luciana Travan*

Section of Human Anatomy and History of Medicine, Department of Medicine, University of Udine, 33100 Udine, Italy

Abstract

We observed the upward displacement of the femoral heads in the skeletal remains of two females unearthed from the medieval cemetery of the monastery of Santa Maria in Valle, in Cividale del Friuli (North-Eastern Italy). Examination of bone vestiges suggests the diagnosis of hip dislocation as the consequence of developmental dysplasia of the hip. In addition, in the youngest subject the first sacral vertebra appears lumbarized and shows the unilateral defect of the right pars interarticularis. Developmental dysplasia of the hip is one of the most common congenital diseases of the musculoskeletal system in newborns. Findings suggest that the skeletons belong to two nuns, who perhaps enter monastic life precisely because of their pathology.

Keywords

hip joint; developmental dysplasia; lumbosacral transitional vertebra; spondylolysis.

Introduction

Cividale del Friuli is a small and ancient town located near Udine, in the North-Eastern Italy, close to Slovenian border. According to tradition it was founded by Julio César and called *Forum Julii*, but Cividale dates back to before the Roman times, as documented by archaeological findings remounting to Palaeolithic and Neolithic times. Occupied in 568 by the Lombards led by King Alboin, *Forum Julii* became the capital of the first Lombard Duchy. In the 8th century, after the victory of the Franks, the city changed its name to *Civitas Austriae*, which today has become Cividale. From 737 to 1238 it was the residence of the patriarchs of Aquileia. It fell under Venice domain along with the rest of Friuli in 1419-20. In 2011, Cividale was declared UNESCO World Heritage Site as part of the “*Italia Langobardorum*” project.

Probably in the middle of the 7th century, the Lombards founded the Benedictine monastery called Santa Maria in Valle which, in the medieval period, became one of the two most important female monasteries in the region, achieving significant prestige and power thanks to numerous donations. Female monasteries often provided shelter and food for orphans, old people, poor and beggars as well as medical care. Santa Maria in Valle always remained a women’s convent, in which lived women of high social status (Tilatti, 2002). The number of the nuns was not particularly high,

* Corresponding author. E-mail: luciana.travan@uniud.it



Figure 1. The skeletons of MSM5 (left) and MSM12 (right). In both images the anomalous position of femora is well appreciable, particularly on the right side.

probably around twenty; the nuns lived in the monastery until the end of the 20th century (Quendolo and Villa, 2009).

In 2008, an archaeological excavation revealed the presence of tombs. Only part of the cemeterial area of the monastery was investigated. Few good graves were found, mostly parts of clothing (buttons, buckles), and a coin dating from the second half of the 10th century. The purpose of this article is to depict two cases of hip dislocation in developmental dysplasia in the skeletal remains of two females (Fig. 1).

Materials and methods

Overall, skeletal remains belonging to 34 individuals, 11 subadults and 23 adults, have been examined.

The skeletons object of the present study are named respectively MSM5 and MSM12. Sex estimations has been conducted using morphological characteristics of the pelvis as well as morphological and metric characteristics of the skull and the post-cranial skeleton. The age-at-death was estimated with standard physical anthropologi-

cal methods (dentition, long bone length, epiphyseal closure, pubic symphyseal face and sacroiliac joint morphology, root dentine transparency, cranial suture obliteration) (Lamedin, 1992; Buikstra and Ubelaker, 1994; Scheuer and Black, 2000). Calculations for stature were performed using long bone measurements. The analysis of metric and non-metric morphological characters was also carried out, as well as the study of the activity markers. All bones were analysed for the presence of pathologies and traumas.

In MSM12, the femoral neck anteversion, which indicates the degree of torsion of the bone, has been assessed by determining the angle between the projection of the line going through the proximal femoral neck region and the surface of the lab bench representing the transepicondylar axis. The angle has been measured on digitally photography in cephalocaudal view (Unnanuntana et al, 2010; Scorcelletti et al., 2020)

Results

MSM5. The skeletal remains are poorly preserved, and many bones are damaged or absent. The remains of MSM5 are those of an adult female (>50 years old); her stature, calculated with the formula by Trotter and Gleser (1958) from the ulna, was 158,5 cm. Muscle attachments are well developed. On the right humerus and on both ulnae the attachments are pronounced (the left humerus was not preserved); the left femur exhibits a prominent *linea aspera*.

The left hip, fragmented and damaged, displays a smooth, shallow depression located posterosuperiorly to the acetabulum. The preserved upper edge of the acetabulum results irregular and flat (Fig. 2). Although in a fragmented state, the head



Figure 2. MSM5, comparative view of the lateral surfaces of the left hip bone of MSM5 (right) and a normal hip bone (left). A shallow depression is appreciable on the posterior superior aspect of the left wing of MSM5 (black arrow). The acetabular roof slopes upwards (white asterisk).



Figure 3. MSM5, left femur. Sagittal view. The head, largely fragmented, appears flat.

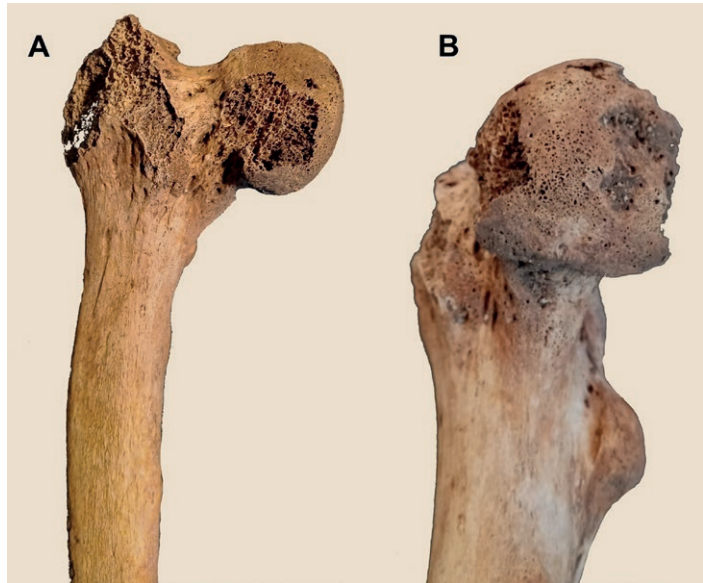


Figure 4. MSM5, right femur. A) Coronal view; B) Sagittal view. In A), ovalization of the femoral head and short neck are well appreciable. In B) Porosities and degenerative changes of the head.

of the left femur appears deformed, with a markedly flattened area (Fig. 3); the less trochanter is very irregular, with macroporosities and spicules (Fig. 3). The great trochanter is too damaged to be evaluated.

The right hip lacks. The right femoral head is small and oval, with porosities and eburnation areas indicative of osteoarthritic changes (Fig. 4). The neck is short.

The few vertebrae that could be examined show large, horizontal osteophytes originating from the margin of the bodies.

MSM12. The skeletal remains are well enough preserved. The remains are those of a young female, 15-16 years-at-death. The muscular attachments are regular, indicating a normal muscle development.

Some malformations can be identified. In the spine, the failure of the first sacral vertebra (S1) that fuses with the sacrum, leaved it with only four sacral segments, being present an extra lumbar vertebra (lumbarization of S1) (Fig. 5). Additionally, the lumbarized vertebra displays the unilateral defect in the right *pars interarticularis* (spondylolysis) and a posterior arch schisis (Fig. 6); the fourth sacral vertebra shows a posterior schisis.

Hip bones are incomplete. The right iliac wing exhibits a deep, rounded depression with degenerative changes and areas of pitting (Fig. 7). The right femoral head is oval and shows marginal osteophyte development; the neck is short (Fig. 8). The femoral neck anteversion is increased (anteversion angle 54.4°) (Fig. 9). The right tibia and fibula do not present alterations.

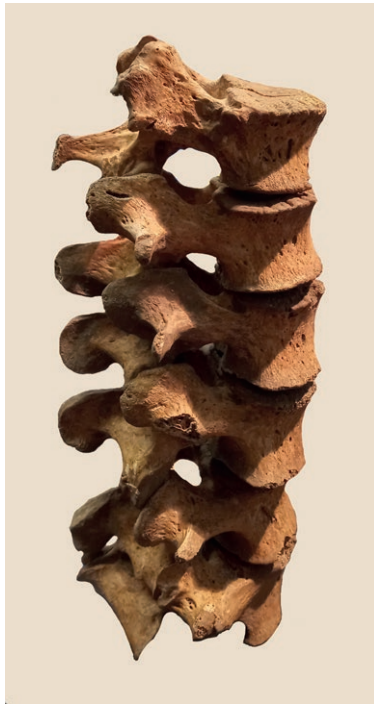


Figure 5. MSM12, lumbar spine. Sagittal view. Lumbar spine is formed by six vertebrae.

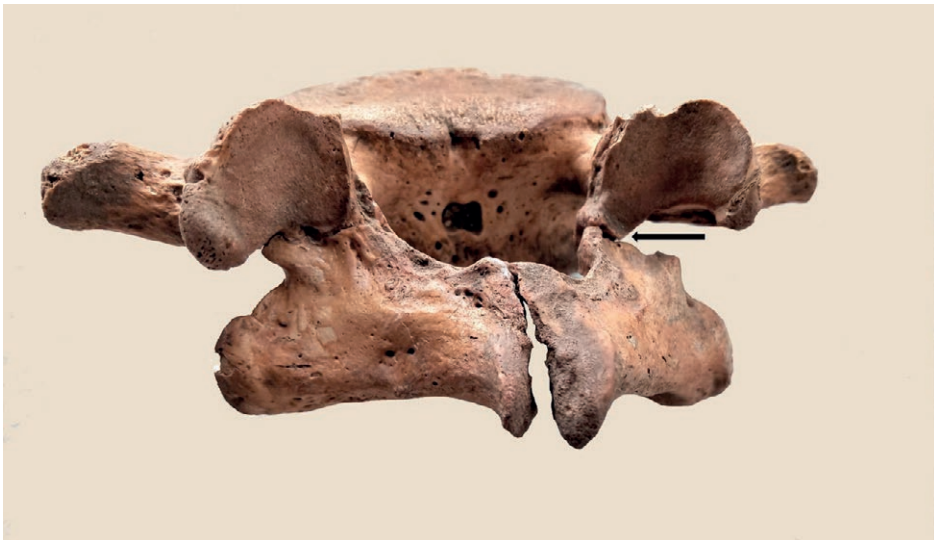


Figure 6. MSM12, L6. Posterior anterior view. Schisis of the spinous apophysis and defect of the right pars interarticularis (spondylolysis) (black arrow).



Figure 7. MSM12, right hip bone, lateral surface. The secondary acetabulum is well visible on the iliac wing (black asterisk). The true acetabulum, incomplete, looks flat (white asterisk).



Figure 8. MSM12, femora, coronal view. Comparative view of the proximal epiphysis. The black arrow indicates osteophyte developing of the inferior margin of the right head.

The left iliac wing displays a thin, irregular layer of bone on the cortex (Fig. 10).

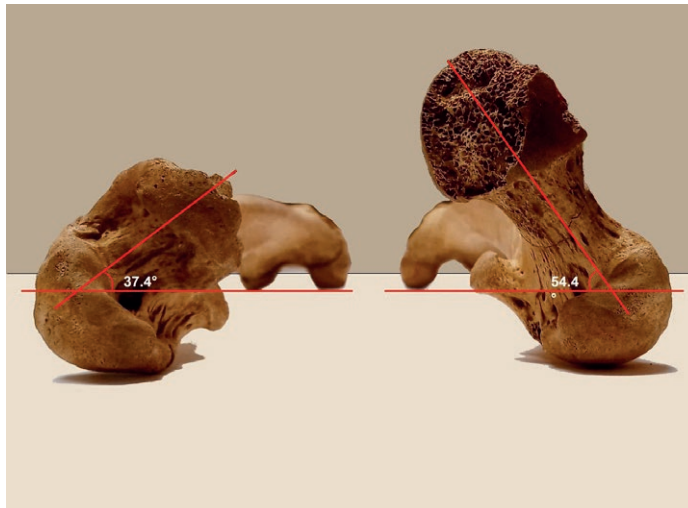


Figure 9. MSM12, femora, cephalocaudal view. Anteverision angles.

The left femoral head is small and deformed; the neck is short (Fig. 8). The femoral neck anteversion is increased (anteversion angle 37.4°) (Fig. 9). The left tibia and fibula do not present alterations. The lesser trochanters are clearly different in shape.

Examination of the rest of the skeleton was unremarkable.

Discussion

The concomitant presence of a false acetabulum in MSM5 left hip (the right hip is missing) and in both hips of MSM12, the aspect of the preserved portion of the true acetabula and the alterations of the proximal femora are consistent with the diagnosis of hip dislocation in developmental dysplasia of the hip (DDH). In DDH, the acetabular cavity is too shallow and the acetabular roof undeveloped, leading to superior dislocation of the femoral head in some instances. In time, the contact between the head and the ilium wing results in formation of a false acetabulum (Fig. 11) The femoral head becomes deformed and the whole geometry of the proximal epiphysis changes, leading in many cases to an increase of anteversion and neck-shaft angles (Clohisy et al., 2009). Even if the incidence varies largely between populations, DDH is considered one of the most common congenital diseases of the musculoskeletal system in newborns. In Italy, the incidence is around 1% and the disease is bilateral in 30-40% of the cases (Farsetti, 2021). Female gender (male to female ratio approximately 1:6), family history, limited foetal mobility, breech position in the last trimester are risk factors for DDH, which shows different severity ranging from a complete dislocation at birth to asymptomatic acetabular dysplasia in adult. (Yang et al., 2019; Rubini et al., 2021). In some cases, DDH occurs with neuromuscular diseases and



Figure 10. MSM12, comparative view of the lateral surfaces of the left hip bone of MSM12 (right) and a normal hip bone (left). The black circle indicates a patchy layer of bone on the posterior superior aspect of the left wing. The acetabular roof seems to slope upwards.

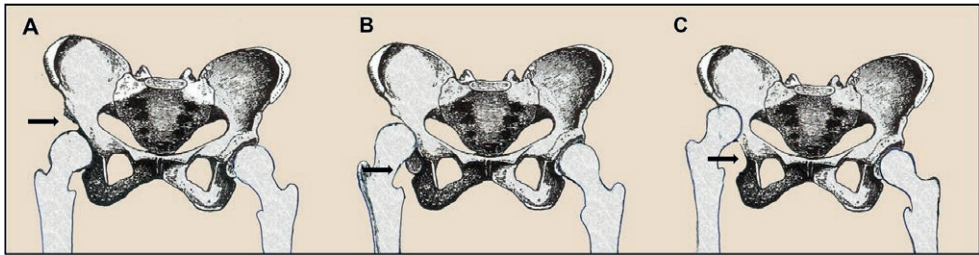


Figure 11. Natural history of DDH. A) The left hip joint illustrates the normal relationship between the femoral head and the acetabular cavity. The right hip shows a flattening of the roof of the acetabular cavity (black arrow), but the femoral head is in the normal position (dysplasia). B) The left hip joint illustrates the normal relationship between the femoral head and the acetabular cavity. The right joint shows the displacement of the femoral head, with some contact between the articular surfaces (subluxation); the true acetabulum is partially empty (black arrow). C) The left hip joint illustrates the normal relationship between the femoral head and the acetabular cavity. The right femoral head is completely displaced, and a false acetabulum is present on the iliac wing (dislocation). The true acetabulum is undeveloped and shallowed (black arrow).

syndromic and nonsyndromic disorders, especially those characterized by joint laxity (i.e. Marfan syndrome, Ehlers-Danlos syndrome) or, conversely, by joint contractures (Castriota-Scanderbeg and Dallapiccola, 2005). Another causal or contributory factor of DDH is the traditional practice of the tight swaddling of infants until walking age, widespread in Middle Ages. Swaddling infants with the lower legs in adducted and extended position results in an altered contact between the acetabulum and femur and may increase the risk of hip dysplasia and dislocation (Clarke, 2014).

The most severe form – that is congenital dislocation – consists of a condition known since ancient times, already described by Hippocrates (400 - 300 BC) (Musielak et al., 2015). Between 1935 and 1936, Marino Ortolani, an Italian paediatrician, first evaluated, diagnosed, and began treating hip dysplasia. Even today, Ortolani's manoeuvre is utilized to assess hip instability in newborns (Spina, 2009).

Symptoms of dislocation depend on age. They may include limping, different lower leg length, limited flexibility in the hip joint. It may cause little or no pain for years, but eventually leads to osteoarthritis.

Diagnostic criteria for developmental dislocation of the hip on skeletal remains are described by Ortner (2003) and, more recently, developed by Mitchell and Redfern (2008). Specifically, Mitchell and Redfern (2008) described the characteristics of the true acetabulum (small, oval or triangular, shallow and with little roof), the false acetabulum and the proximal femur. Located superiorly or posterosuperiorly to the true acetabulum, the false acetabulum can have four different morphologies: smooth and shallow depression (type 1), fine layer of bone without a depression (type 2), elevated bony plaque (type 3), deep and round cavity (type 4). The femoral head can conserve good proportions but results oval in anteroposterior plane in type 4 acetabulum, or be flat or mushroom-shaped in type 1, 2, 3.

The present case MSM 5 exhibits a shallow depressed area on the lateral aspect of the left iliac wing (type 1); the true acetabulum is quite incomplete; the only visible part of the roof is deformed and receding. Regrettably, the right hip is missing. Both femoral heads, even if incomplete, are deformed, with flat aspects (the left one) and

asphericity (the right one). Degenerative changes are appreciable, indicating the use of the joints.

Both hips of MSM 12 are present. On the right iliac wing, a deep, rounded depression is evident, indicative of a type 4 acetabulum; the left one exhibits a fine layer of new bone (type 2 acetabulum). However, different types of false acetabula have been documented in the same individual (Mitchell and Redfern, 2008). The preserved parts of the true acetabula appear flat and irregular. Accordingly with the different morphology of the false acetabula, also the proximal femoral epiphysis shows different aspects: the right femoral head, incomplete, seems nearly normal in size but ovalized and, despite the young age, initial osteoarthritis changes are present along the inferior border. These aspects are congruent with the type 4 of acetabulum. The neck is short and the anteversion angle (value 54.4°) largely exceeded the normal value of about 15° . The left head is severely deformed, the neck is short and the anteversion angle measures 37.4° . The right lesser trochanter is more elongated, while the left one seems to be in a higher position. Remarkably, MSM12 also displays a lumbosacral transitional vertebra. A lumbosacral transitional vertebra occurs as either sacralization of the lowest lumbar segment or lumbarization of the most superior sacral segment of the spine. It arises because of mutations in the Hox genes (Gopalan et al., 2018). In the present case, the first sacral vertebra is lumbarized and presents a unilateral defect in the right pars interarticularis (spondylolysis) and a posterior arch schisis. A recent study has demonstrated the association of the increased frequency of spinal anomalies, seen on standard hip radiographs, and DDH (Sun et al., 2021). Specifically, acetabular deficiency characterized by anterior acetabular undercoverage can result in anterior pelvic tilt and compensatory hyperlordosis which, in turn, enhance axial load on the pars interarticularis (Sun et al., 2021). Moreover, hip osteoarthritis, even at a young age, appears to be more frequently associated with this type of acetabular deficiency (Jessel et al., 2009). A similar case has been described by Wakely (1993) in a medieval female.

In the present cases, the post-mortem damage of the bones does not certainly allow to rule out a traumatic cause of the dislocations. However, it seems very unlikely: bilateral traumatic dislocations are very rare with few cases reported in literature. A high energy trauma is needed and nowadays it occurs more commonly among young male patients, due to vehicle accidents (Buckwalter et al., 2015).

Mostly sporadic cases of dislocations caused by DDH have been described in paleopathological literature, but in two large skeletal series excavated from a London cemetery and from Digne (France), the prevalence of dislocation in developmental dysplasia was found to be 2.7‰ and 13.1‰ respectively (Mitchell and Redfern, 2007; Mafart et al., 2007). To explain the occurrence of two cases in 34 individuals (prevalence 5.8%) we should remember that, from the 6th century, the oblation, that is the offering to God and therefore to the monasteries, of boys and girls was widely practiced, especially in Benedictine monasteries. Carried out by the parents, until the Council of Trent (1563) it had an irrevocable character. At first, only the children member of upper class or noble families were oblates, and a large gift (money or lands) was expected to accompany the child. Later, the oblation was extended and the poor were allowed to donate their children. In many cases, the oblation was a method to safeguard the well-being of other siblings or the family. Daughters were more often oblates, even by wealthy family. Frequently, the oblates children were

physically deformed or mentally defective, and it was believed that children born deformed were the result of incorrect behaviours (i.e., conception occurred during the menstrual cycle) (Boswell, 1984; McCracken, 2003). However, not all the nuns were child oblates: in many cases they were adult converts, often widows (Osheim, 1983).

Hence, we assume that the two cases here presented concern two women that during childhood, or later, became nuns, probably due to the pathology they suffered. Since in DDH genetic factors play an important role, a consanguinity cannot be excluded.

References

- Boswell J.E. (1984) *Expositio and oblatio: the abandonment of children and the ancient and medieval family*. *Am. His. Rev.* 89: 10-33.
- Buckwalter J., Westerlind B., Karam M. (2015) Asymmetric bilateral hip dislocations: a case report and historical review of the literature. *Iowa Orthop. J.* 35: 70-91.
- Buikstra J.E., Ubelaker D.H. (1994) Standards for data collection from human skeletal remains, Research Series, no. 44. Arkansas Archaeological Survey, Fayetteville.
- Castriota-Scanderbeg A., Dallapiccola B. (2005) *Abnormal skeletal phenotypes: from simple signs to complex diagnoses*. Springer-Verlag Berlin Heidelberg, Germany. pp. 268-271.
- Clarke N.M.P. (2014) Swaddling and hip dysplasia: an orthopaedic perspective. *Arch. Dis. Child.* 99: 5-6.
- Clohisy J.C., Nunley R.M., Carlisle J.C., Schoenecker P.L. (2009) Incidence and characteristics of femoral deformities in the dysplastic hip. *Clin. Orthop. Relat. Res.* 467: 128-134.
- Farsetti P. *Displasia e lussazione congenita dell'anca*. In: Grassi FA, Pazzaglia UE, Pilato G. *Manuale di ortopedia e traumatologia*, EDRA, Milano, 2021.
- Gopalan B., Yerramshetty J.S. (2018) Lumbosacral transitional vertebra-related low back pain: resolving the controversy. *Asian Spine J.* 12: 407-415.
- Jessel R.H., Zurakowski D., Zilkens C., Burstein D., Gray M.L., Kim Y.J. (2009) Radiographic and patient factors associated with pre-radiographic osteoarthritis in hip dysplasia. *J. Bone Joint. Surg. Am.* 91: 1120-1129.
- Lamendin H., Baccino E., Humbert J.F., Tavernier J.C., Nossintchouk R.M., Zerilli A. (1992) A simple technique for age estimation in adult corpses: the two criteria dental method. *J.F.S.* 37:1373-1379.
- Mafart B., Kefi R., Béraud-Colomb E. (2007) Palaeopathological and palaeogenetic study of 13 cases of developmental dysplasia of the hip with dislocation in a historical population from southern France. *Int. J. Osteoarchaeol.* 17: 26-38.
- McCracken P. (2003) The curse of Eve, the wound of the hero: blood, gender, and medieval literature. Philadelphia, PA: University of Pennsylvania Press. Pp. 63-64.
- Mitchell P.D., Redfern R.C. (2007) The prevalence of dislocation in developmental dysplasia of the hip in Britain over the past thousand years. *J. Pediatr. Orthop.* 27: 809-892.
- Mitchell P.D., Redfern R.C. (2008) Diagnostic criteria for developmental dislocation of the hip in human skeletal remain. *Int. J. Osteoarchaeol.* 18:61-71.
- Musielak B., Idzior M., Józwiak M. (2015) Evolution of the term and definition of dysplasia of the hip - a review of the literature. *Arch. Med. Sci.* 12: 1052-1057.

- Ortner D.J. (2003) Identification of pathological conditions in human skeletal remains. Elsevier Science, San Diego, CA. Pp. 471-474.
- Osheim D.J. (1983). Conversion, conversi, and the Christian life in late medieval Tuscany. *Speculum*. 58: 368-390.
- Quendolo A., Villa L. (2009) Primi interventi di valorizzazione del Monastero di Santa Maria in Valle a Cividale del Friuli. *Forum Iulii* (2008). XXXII: 185-202.
- Rubini M., Cavallaro A., Calzolari E., Bighetti G., Sollazzo V. (2008) Exclusion of COL2A1 and VDR as developmental dysplasia of the hip genes. *Clin. Orthop. Relat. Res.* 466: 878-883.
- Scorcelletti M., Reeves N.D., Rittweger J., Ireland A. (2020) Femoral anteversion: significance and measurement. *J. Anat.* 237: 811-826.
- Scheuer L., Black S. (2000) *Developmental Juvenile Osteology*. Oxford, UK: Elsevier Academic Press.
- Spina N. (2009) Marino Ortolani da Ferrara: uno "scatto" per entrare nella storia. *G.I.O.T.* 35: 99-106.
- Sun J., Chhabra A., Thakur U., Vazquez L., Xi Y., Wells J. (2021) The association of lumbosacral transitional vertebral anomalies with acetabular dysplasia in adult patients with hip-spine syndrome. *Bone Joint. J.* 103-B:8: 1351-1357.
- Tilatti A. (2002) Monachesimi femminili in Friuli nel Duecento. In: Scaloni C. *Il monachesimo benedettino in Friuli in età patriarcale*. Atti del convegno internazionale di studi Udine-Rosazzo, 18-20 novembre 1999. Udine: Forum. P. 190.
- Trotter N., Gleser G.C. (1958) A re-evaluation of estimation of stature based on measurements of stature taken during life and of long bones after death. *Am. J. Phys. Anthropol.* 16: 79-123.
- Unnanuntana A., Toogood P., Hart D., Cooperman D., Grant R.E. (2010) Evaluation of proximal femoral geometry using digital photographs. *J. Orthop. Res.* 28: 1399-1404.
- Wakely J. (1993) Bilateral congenital dislocation of the hip, spina bifida occulta and spondylolysis in a female skeleton from the Medieval cemetery at Abingdon. *J. Paleopath.* 1: 37-45.
- Yang S., Zusman N., Lieberman E., Goldstein R.Y. (2019) Developmental dysplasia of the hip. *Pediatrics.* 143: e20181147.