Original article: paleopathology

Paleopathological evidence of Legg-Calve'-Perthes from the medieval cemetery of St. Agostino in Caravate, Northwestern Italy

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Abstract. Legg-Calvé-Perthes (LCPD) is a rare childhood disorder that induces the osteochondrosis of the femoral head. Almost all authors agree that the condition involves the obstruction to the bloody supply of the growing femoral head. The etiology is debated, as some authors claim that the triggering process of LCPD is unknown. Others argue that the onset of this affection can be prompted by several factors such as exogenous causes, trauma, metabolic issues, hematological disease, infections. LCPD has been recognized in archaeological material for nearly a century. The signs of the pathology are well described in the literature, but few paleopathological cases have been described. Here we report morphologic analyses of a skeleton retrieved during the archaeological investigations of the medieval cemetery of the church of St. Agostino in Caravate (Varese, Italy, 12^{th,} and 13th centuries). After an accurate differential diagnosis, the observed features suggest a conclusion of avascular necrosis of the right femoral head and unilateral evidence of LCPD.

Key words: mushroom femoral head, joint disease, childhood disorder, femoral head avascular necrosis

Introduction

Legg-Calvé-Perthes disease (LCPD) is grouped into circulatory diseases, as a specific case of osteochondrosis affecting the femoral head of children, with prevalence among males. It usually arises between the ages of 5 and 9 years, with an increment at the ages of 6 or 7 (1). Affected children present a growth delay.

The disease is provoked by avascular necrosis caused by an interruption of the blood flow that reaches the epiphysis of the femoral head (2). The deposition of new trabecular bone and the resorption of necrotic bone occur simultaneously, but in the subchondral area, resorption is greater than deposition. The superior and anterolateral aspects of the femoral head are the most affected, showing deformation, flattening, and widening with the femoral neck demonstrating shortening and broadening, causing coxa vara (3,4). The femoral head, often described as "mushroom-shaped", takes this aspect because of the forces acting upon it and the lack of endochondral growth (5).

No family or hereditary features have been identified, but the incidence of LCPD is from 1% to 20% more frequent among family members of affected children (6). Moreover, a correlation has been identified with some mutations of the COL2A1 gene (7).

Some authors still claim that the triggering process of LCPD is unknown, others argue that this pathological condition can be prompted by several factors such as exogenous causes, trauma, metabolic issues (8), hematological diseases, infections, or any etiology that causes a serious obstruction of the blood supply to the growing head of the femur (4,6).

LCPD is a pathology that constrains the mobility of individuals, despite a certain tendency to self-resolution. Complete healing depends on the degree of

osteonecrosis and deformity of the femoral head, the location of the lesion, and the age of onset of the disease. The most common complication is degenerative joint disease (6).

In this paper, we present a possible case of LCPD observed in an individual recovered in the medieval cemetery of the church of St. Agostino in Caravate, which integrates our anthropological knowledge of the territory (9-11).

Materials and methods

The individual was found during the archaeological excavations conducted in the cemetery area of the medieval site of St. Agostino in Caravate (Varese, northern Italy). The cemetery of the small church of Caravate has been under investigation since 2002 to 2018. The excavated area discovered a total of 20 tombs and the study of human remains revealed interesting cases from anthropological and paleopathological point of view (12,13). The skeleton under study (T. 18) was located outside the church, oriented N-S, and, according to the archaeological stratigraphy, dated to a time between the 12th and 13th centuries. The skeleton was well preserved and most anatomical parts were represented.

Sex was determined through the morphological features of the os coxae (14,15). Age at death was assessed through degenerative changes of the auricular surface and pubic symphysis (16,17), sacrum (18), and of the auricular surface and acetabulum (19). Stature was calculated using the formulae for white males from Trotter and Gleser (20).

The skeleton showed pathological lesions on the right hip, involving both the femoral head and the acetabulum. The lesions were morphologically analyzed based on the specific paleopathological literature (4,21,22).

Results

Individual of T.18 was a male aged 45-50 years, measuring approximately 166 cm tall.

The individual exhibited bone changes in the right hip involving the femoral head and the acetabulum, which appear to be the result of a pathological condition (Fig.1). The left hip showed no pathological changes.

The right femoral head was flattened superiorly and larger than that the left one, with the edges widening into a mushroom shape. The articular surface showed porosity and exostosis. It could not be stated with certainty whether the fovea capitis was dislocated or resorbed due to the incompleteness of the femoral head (Figs. 2,3).

Figure 1. Bones of righ hip of individual T 18 showing pathological alteration involving both the proximal epiphysis of the femur and acetabulum.

Figure 2. Medial view of the flattened right femoral head.

Figure 3. Particular of right acetabulum showing articular degeneration.

Figure 4. Comparison between bones of both the left and right acetabulum.

There was no substantial dislocation of the center of the femoral head from the axis of the shortened and thickened femoral neck.

The right acetabulum was markedly shallower in comparison to the left. Its borders were hyper-developed, with a diameter of 73 mm (differing from the 51 mm of the left coxal bone) and presented important bone neoformation (Fig. 4). The inner surface was also characterized by great porosity. There were no traces of neo acetabulum in either the proximal or the dorsal direction.

Discussion and conclusion

The individual of T.18 showed a mushroom-shaped femoral head, which is one of the most striking and representative features of LCPD. The increasing size of the femoral head can be explained by several factors, such as the necrosis of the bone, natural remodeling, and the potential adherence of small necrotic fragments that might have been detached from the bone during the pathological process (23). The deformed femoral head has led to modifications of the acetabular shape, inducing a severe degenerative disease on both articular surfaces.

Sex determination is also suggestive of the diagnosis of LCPD, as it primarily involves European males (2).

To proceed to an accurate differential diagnosis, we considered congenital hip dislocation (CHD), slipped capital femoral epiphysis (SCFE), multiple epiphyseal dysplasia (MED), Gaucher's disease (GD), infantile hypothyroidism, sickle cell disease (SCD), and various bone dysplasias. All these conditions can produce similar lesions on the femoral head, making diagnosis difficult (24,25).

CHD can be ruled out since in this case there is the absence of a pseudo-acetabulum to accommodate the dislocated femoral head, and the aspect of the original acetabulum suggests its functionality until the individual's death. We also excluded SCFE because in this condition the epiphysis is characterized by head center dislocation toward the neck axis, shortening and thickening of the neck, with the formation of a new acetabulum at the ilium. All these features together are absent in the current case (4,26).

Other congenital affections of the hip with bilateral deformities can mimic LCPD. We have considered GD, MED, infantile hypothyroidism, and other types of osteonecrosis due to SCD, but they usually involve both hips and other joints, whereas in our case only one of the hips was affected, although in 10% of cases LCPD can affect both sides (27-30).

In conclusion, morphologic examinations of the right hip of the individual buried in T.18 of the medieval cemetery of St. Agostino in Caravate suggest a diagnosis of unilateral LCPD.

The etiology of the disease is still unknown, although the role of traumatic, genetic, metabolic, nutritional, environmental, hormonal, and hematologic factors as the potential causes of the changes at the femoral head has been discussed (6). Of the proposed

etiological theories, one seems the most likely: there is experimental evidence that the original occlusion of the precarious blood supply to the femoral head may be caused by excessive fluid pressure from an inflammatory or traumatic synovial effusion in the hip. Approximately 5% of children with transient hip synovitis show the complication of Legg-Calvé-Perthes disease. According to some authors, it is likely that multiple factors can combine in a constitutionally vulnerable child and cause the disease (31,32).

When comparing our case with clinical examples, we can hypothesize that in the absence of a suitable treatment the lesions got worsened over the individual's life. In effect, when medical treatment is provided, the complete regeneration of Perthes disease takes 2-5 years to accomplish. On the other hand, when an individual lives for too long with this disease, the natural remodeling of the bone leads to a permanent mushroom shape of the head with an indiscernible fovea capitis and corresponding ligaments attachment. Based on these hypotheses, in the individual of T.18, the first symptoms probably appeared at a very early age (before the age of 10).

The disease encompasses a wide spectrum of manifestations, from mild with no long-term sequelae, to severe with permanent degenerative changes of the hip joint. Occurrences include deficit in hip abduction and internal rotation nature, along with Trendelenburg gait in advanced stages (33).

LCPD can be a self-limiting disease, however, in our case, the appearance of the acetabulum and femoral head suggests the functionality of the right hip until the individual's death.

Acknowledgments: The authors wish to thank Dr. Marta Licata, scientific responsible for the project that promoted the study of the cemetery area of the church of St. Agostino in Caravate. Finally, we want to thank the Cariplo Foundation and the Community Foundation of Varese for funding this project.

References

1. Rothschilde B, Martin L. Paleophatology: Disease in the Fossil Record. London Tokio: Boca Raton CRC Press; 1993.
2. Chaudhry S, Phillips D, Feldman D. Legg–Calvé–Perthes disease an overview with recent literature. Bull Hosp Joint Dis 2014; 72:18-27.
3. Aufderheide A. The Cambridge Encyclopedia of Human Paleopathology. Cambrige: University Press; 1998.
4. Herrerín J, Gallarda MD. Legg–Calvé–Perthes disease and unifocal eosinophilic granuloma in a Visigoth from the Duratón necropolis (Segovia, Spain). Int J Osteoarchaeol 2012; 22: 86-97.
5. Salter RB. Textbook of Disorders and Injuries of the Musculoskeletal System. 3rd Ed. Philadelphia Lippincott Williams & Wilkins; 1999.
6. Thompson GH, Salter RB. Legg–Calve–Perthes Disease. Clinical Symposia 1986; 38:2
7. Li N, Yu J, Cao X, Wu QY, Li WW, Li TF, Zhang C, Cui YX, Li XJ, Yin ZM, Xia XY. A novel p. Gly630Ser mutation of COL2A1 in a Chinese family with presentations of Legg-Calvé-Perthes disease or avascular necrosis of the femoral head. PLoS On. 2014; 20.
8. Larentis O, Tonina E, Iorio S, Gorini I, Licata M. Osteological evidence of metabolic diseases from a post medieval North Italy archaeological site. J Mat Fet Neom Med(1) 2019; 33(16):1-131.
9. Licata M, Larentis O, Tesi C, Fusco R, Ciliberti R. Tourism in the Time of Coronavirus. Fruition of the "Minor Heritage" through the Development of Bioarchaeological Sites. A Proposal. Heritage 2021; 4:759-74.
10. Licata M, Larentis O, Badino P, Fusco R, Tesi C. Toward the valorization of our anthropological and paleopathological heritage. The musealization of the osteoarchaeological contexts. Med Histor 2020; 4:45-6.
11. Larentis O, Gorini I. Bioarcheology in the northwest Italy. Our experience. Med Histor 2019; 3:46-7.
12. Lazzati AMB, Levrini L, Rampazzi L ET al. The diet of three medieval individuals from Caravate (Varese, Italy). Combined results of ICP-MS analysis of trace elements and phytolith analysis conducted on their dental calculus. Int J Osteoarchaeol 2016; 26:670-68.
13. Tonina E, Licata M, Larentis O, Tesi C, Fusco R. A severe case of biparietal thinning in a medieval skull from a northern Italy necropolis. J Craniofac Surg 2021; 7–13.
14. Phenice T. W. A newly developed visual method of sexing the os pubis. Am J Phys Anthropol 1969; 30:297-30.
15. Acsadi G, Nemeskeri J. History of human life span and mortality. Budapest: Akademiai Kiado; 1970.
16. Lovejoy C. Dental wear in the Libben population: its functional pattern and role in the determination of adult skeletal age at death. Am J Phys Anthropol 1985; 68:47-56.
17. Brooks S, Suchey JM. Skeletal age determination based on the os pubis: a comparison of the Acsádi-Nemeskéri and Suchey-Brooks methods. Hum Evol 1990; 5:227-38.
18. Passalacqua NV. Forensic Age-at-Death Estimation from the Human Sacrum. J Forensic Sci 2009; 54:255-62.
19. Rougé-Maillart C, Vielle B, Jousset N, Chappard D, Telmon N, Cunha E. Development of a method to estimate skeletal age at death in adults using the acetabulum and the auricular surface on a Portuguese population. For Sci Int 2009; 188:91-5.
20. Trotter M, Gleser, GC. A re-evaluation of estimation of stature based on measurements of stature taken during life and of long boners after death. Am J Phys Anthropol 1958; 16:79-123.

21. Smrcka V, Marik I, Svenssonova M, Likovsky J. Legg–Calvé–Perthes disease in Czech archaeological material. Clin Orthop Relat 2009; 467:293-7.
22. Ortner DJ Identification of Pathological Conditions in Human Skeletal Remains, 2nd ed. Academic. Amsterdam: Elsevier Science; 2003.
23. Roberts C, Manchester K, The archaeology of Disease. New York: Cornell University Press: 1995.
24. Kozlowski K, Beighton P. Gamut Index of Skeletal Dysplasias: An Aid to Radiodiagnosis. 2nd Ed. London, England: Springer Verlag; 1995.
25. Spranger JW, Brill PW, Poznanski AK. Bone Dysplasias: An Atlas of Genetic Disorders of Skeletal Development. 2nd Ed. New York, NY: Oxford University Press; 2002.
26. Rosenfeld, S.B, Herring, J.A, Chao J.C. Legg–Calvé–Perthes disease: a review of cases with onset before six years of age. Bone Joint Surg Am 2007; 89:2712-22.
27. Anderso, LA, Erickson JA, Severson E, Peters CL. Sequelae of Perthes disease treatment with surgical hip dislocation and relative femoral neck lengthening. J Pediatr Orthop 2010; 30:758-66.
28. Scott B. Rosenfeld, John A. Herring, and John C. Chao, Legg-Calve-Perthes Disease: A Review of Cases ´ with Onset Before Six Years of Age. J Bone and Joint Surg 2007; 89: 2712-22.
29. Superti-Furga A, Unger S. Nosology and classification of genetic skeletal disorders: 2006 revision. Am J Med Genet 2007; 143:1-18.
30. Manzon VS, Ferrante Z, Giganti M, Gualdi-Russo E. On the antiquity of Legg–Calvé–Perthes disease: Skeletal evidence in Iron Age Italy. Homo 2017; 68:10-17.
31. Schwarz E. A typical disease of the upper femoral epiphysis. Clin Orthop Rel Res 1986; 209:5.
32. Nevelos AB. Perthes' disease: the family tree. Clin Orthop Relat Res 1986; 209:13-22.
33. Divi SN, Bielski RJ. Legg-Calvé-Perthes Disease. Pediatr 2016; 45:144-9.

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