Orthopaedic Complications

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Abstract

The objective of this paper is the presentation of obesity-related musculoskeletal problems in childhood while a) focusing on the prevention of anticipated discomforts in adulthood and b) providing information on how best to address such complications in children who are obese.

One of the most common problems found in young people is, in particular, the strain on the lower extremities. The results of which can range from pes valgus and pes planus to genu valgum or knock-knee deformity caused by excessive anatomical and mechanical strain. Limited activities are often the first signs of dynamic impairment and usually manifest as shortening of the hip flexor and knee extensor muscles (e.g. psoas and quadriceps). Such shortening often causes retropatellar symptoms (pain at the anterior surface of the knee joint) or induces a hyperlordosis (exaggerated lumbar curve in the spine or "swayback").

However, some well-known childhood orthopaedic conditions tend to present more commonly in patients afflicted with obesity. These conditions include Perthes' disease, Osgood Schlatter's disease, calcaneal apophysitis and slipped capital femoral epiphysis. Again, the lower extremities are mainly affected.
Early symptoms in the axial skeleton begin with signs of overstraining of the lumbar vertebrae; these range from hyperlordosis to Scheuermann's disease with the exaggerated hunchback.

If size-weight ratios are not improved by the end of growth, early onset of arthrosis, particularly of the knee joints, spine and feet, is likely. In addition to the mechanical factors, also hormonal changes can contribute to an acceleration of arthrosis. Degenerative changes of the locomotor system and Charcot foot become central topics particularly in patients with diabetes. From an orthopaedic perspective, this negatively formulated outlook should be countered with early identification and a positive recommendation on how to manage such complaints.

Weight-loss and increased physical fitness of children and adolescents who are morbidly obese - although difficult - can successfully reduce the risk of the above-referenced orthopaedic problems.

Introduction

Musculoskeletal problems occur more often in children who are obese compared to those of healthier weights. Obesity has a significant negative impact on the locomotor system of the lower extremities and the lumbar spine. The question about the aetiology of obesity is controversially discussed from the perspectives of physical exercise and discomfort. It is unknown whether unfavourable musculoskeletal conditions which cause discomfort lead to a lack of exercise and thus to obesity, or if children who are obese suffer excessive strain on the locomotor system, leading to axial deformities and discomfort. Nevertheless, there are some known correlations, which should be considered in the care of children with obesity.

From an orthopaedic perspective, weight alone is not pathological. Bones have a high potential for adaptation and in particular bony architecture develops in response to dynamic muscle pull and mechanical impact. As such, a child classified as obese but physically active would develop bones adapted to their load compared to a child classified as obese but inactive. In the long term however, a correlation of arthrosis of the joints is observed, the cause of which may be found in both the synovial environment in addition to the mechanical situation. With rising BMI (body mass index), the probability of musculoskeletal problems increases, and therefore, so too the occurrence of arthroses. (1-5)

Perthes' disease

Perthes' disease (Legg-Calvé-Perthes' disease) is an avascular necrosis of the femoral head, which progresses in stages and peaks in children between the ages of 5 and 7.

Perthes disease is an orthopaedic diagnosis with an affinity for patients suffering from obesity and particularly presents in boys. This obesity-association is observed less frequently in pre-school aged children.

There is no definite correlation between body mass index (BMI) and the severity and extent of an aseptic necrosis of the femoral head, though correlational data proposes leptin as having a role in the pathogenesis of Perthes disease(6). .Similarly, the limited mobility in Perthes` disease inevitably leads to an increase in weight and there is a correlation between age and the occurrence of changes and the severity of the necrosis. The later Perthes' disease occurs, the more unfavourable the prognosis.

The developing coxa magna and deformation of the femoral head lead to restricted hip joint mobility and in the long term, it can be considered as pre-osteoarthrosis. The therapeutic treatment options can be described as limited. A direct influence on the stage-like progression of the disease is currently unknown. Given these conditions, treatment focuses on maintaining the shape of the femoral head, the hip joint mobility and containment between the femoral head and the unaffected acetabulum. Physiotherapy is recommended for maintaining joint mobility, while also relieving the hip joint by reducing physical activities with axial strain and substituting instead with physical activities that are non-weight bearing such as cycling or swimming. From the perspective of obesity, reducing physical activity can be counter-productive and can affect weight management. As such, in this group it is essential that weight-bearing

activities are modified in order to boost energy expenditure while optimising the integrity of the femoral head. Tests attempting to disrupt the stage-like progression of the disease by administering circulation-promoting infusions are still at the trial stage. In contrast, surgical intervention to reposition the femoral head, such as intertrochanteric varus osteotomy, is necessary in individual cases depending on the deformity. [Fig. 1a: Perthes´ disease](7),

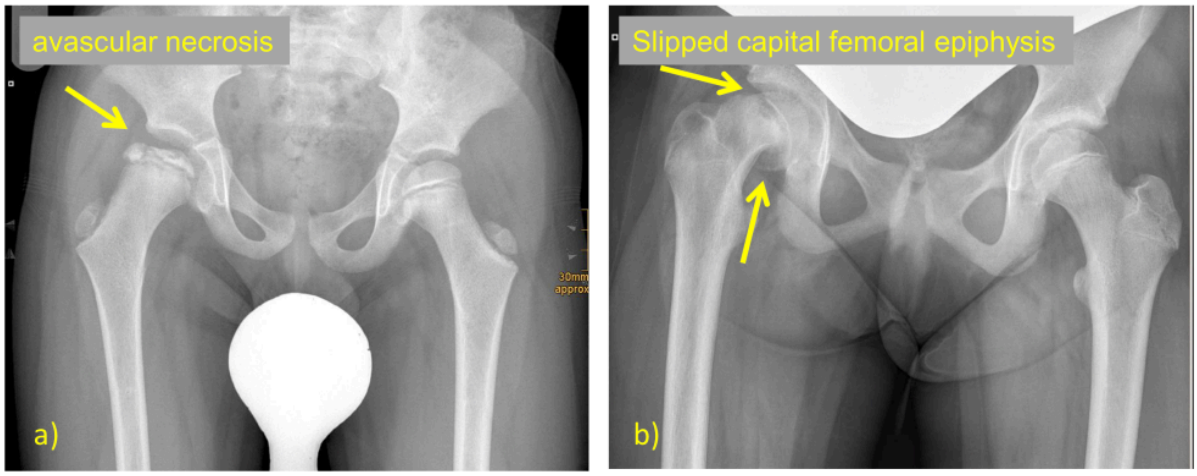

Figure 1

Slipped capital femoral epiphysis

A slipped capital femoral epiphysis (SCFE) is a disorder of the growth plate of the femoral head. It is expressed as either a slow slippage of the femoral-head plate (lenta) or it can be precipitated by an acute event during a trauma.

Slipped capital femoral epiphysis is now the typical hip problem in adolescents who are obese. This means that in cases of acute or persistent hip discomfort, the entire symptomatology must be considered in a differential diagnosis. Also hip problems should always be considered in cases of uncertain knee pain, and persistent limping. In order to diagnose a SCFE, a comparison image of the hips and an axial image must be taken (anterior and frog-leg lateral views). The reason is that an incipient slippage of the femoral epiphysis is not always discernible when only comparing images taken an anteroposterior-view of the hips.

Clarification on both sides is also required as in 50% of all cases both sides are affected. Therefore, surgical intervention of both sides by pinning or screwing the femoral head epiphysis is recommended.
A delayed diagnosis increases the amount of slippage and typically requires very extensive surgical intervention. Thus, in cases of low to moderate slippage, arresting the progressive process with the insertion of K-wires is usually sufficient, whereas in cases of extensive slippage due to misalignment, a corrective osteotomy with all of its associated risks is inevitable. The extent of slippage and the extent of pre-arthrosis are directly related. In contrast to Perthes' disease, which has an untreatable stage-like progression, an early diagnosis and surgical intervention can halt the progression of slipped capital

femoral epiphysis. [Fig. 1b: Slipped capital femoral epiphysis](8-10),

The post operative management of children with SCFE will vary from centre to centre and will depend on whether the slip was stable or unstable and whether one or both hips have been treated. Children should be referred to physiotherapy in order to learn safe mobilisation for the home and school environment. In some cases crutches or a walking frame may be used to reduce the amount of weight bearing through the hip/s. Such aids should be appropriate for the weight of the child and in many cases bariatric crutches and frames will be needed. For many children who are obese, balance and coordination can be impaired and adequate mobility training will be necessary to ensure that the child moves safely and confidently when walking and when ascending/descending stairs. In other cases, a wheelchair may be necessary for use over long distances or in school. The child should be facilitated to be as independent as possible and if discharged post-operatively with a wheelchair, should have the opportunity to practice mobilising with a frame/crutches as an outpatient.

As children's movement and energy expenditure will be limited post operatively it is essential that advice is given regarding appropriate nutrition (especially reducing the intake of energy-dense foods and drinks) so that weight-gain can be avoided and thus hamper full rehabilitation and return to health-enhancing levels of physical activity (60 mins of moderate-vigorous intensity daily). In the post-operative period (depending on the level of healing) non-weight bearing activities such as swimming and cycling may be useful. Post-operative physiotherapy rehabilitation may be required in cases where children have become very deconditioned or where confidence in movement has been reduced.

Upon review of the patient, careful attention should be paid to the presence of pain as avascular necrosis or infection are post-operative possibilities.

Calcaneal apophysitis

The symptomatology of calcaneal apophysitis (Sever's disease) is usually found in children between the ages 5 and 12. The aetiology is believed to be an imbalance of mechanical loading (large body weight, lots of physical activity) and reduced load capacity due to biological conditions. It is a self-limiting disorder and the associated discomfort can be treated by , topical therapy, cryotherapy as well as stretching of the tendoachilles and temporary elevation of the heel (using a heel cushion) to reduce the tension in the Achilles tendon(11). As part of a differential diagnosis, Haglund's deformity, calcaneal bursitis, or a bone cyst must be excluded.(11, 12)

Leg axis

In children who are obese, axis misalignment of the lower extremities is much more common than in the population with healthy BMI. The typical appearance of the leg axis in obesity is characterized by knock-knees. An increasing circumference of the thigh inevitably leads to abduction of the lower extremities, which characterizes the clinical picture, depending on the distribution of fat. The anatomical shape of the leg axis needs to be distinguished between an abduction adjustment (with normal anatomical axis of the leg but with pathological positioning) and genu valgum as pathology of the anatomic leg axis in its

osseous form. This misalignment of the axis develops very early on. It should be noted that natural leg axis development in early childhood, from infancy (bow-legged), temporarily changes into knock-knee; however, it is naturally corrected by school age. This correction of the natural axial alignment is missing in a subset of morbidly obese children(13). An important consideration is that the knee-joint mechanical loading is much worse in genu valgum (knock-knee position) than in an abducted (soft tissue related) position of the lower extremities [Fig. 2 a: Knock knees (Genu valgum), Fig. 2 b: Normal leg axis = abducted position of the lower extremities]. A genu varum (bow-leg) is not commonly expected among children who are obese, though the incidence of this condition is on the rise in young children(14). .On the contrary, genu valgum as a predominant malalignment of the distal extremities is frequent in youth with morbid obesity(15). A recent study showed that, besides static consequences, there are also dynamic implications of said malalignment in obesity. Thus, timely guided correction of angular deformity of the knee seems pivotal in order to avoid osteotomy or osteoarthritis later in life.(16) This is of particular importance as early lesions of the knee cartilage could be found in young patients with morbid obesity.(4) Given the above-referenced conditions, children with morbid obesity should have an orthopaedic examination of the axis ratios upon the onset of puberty.

If genu valgum is diagnosed, a minor intervention using temporary epiphysiodesis can help to affect growth positively. On the inner side of the knee depending on the location of the axis problem (thigh or lower leg) a plate and two screws or a staple are used to stop temporarily the growth of the epiphyseal plate and therefore, correct the leg axis. A correction of 5° genu valgum takes around 1 year at the last growth spurt, with wide individual range. After achieving the correct leg axis position, the osteosynthesis material is removed and growth can continue as usual. Early correction of the axis should be avoided due to the residual risk of over-correction [Fig. 2 c: Temporary epiphysiodesis to correct knock knees].

Conservative therapies using orthotics may affect the leg aspect ratio in the early stages of life. At this time, however, the impact of such devices on further development of the leg axis and the mechanical load due to the adiposity is unknown. An effective prophylaxis is thus unlikely.

However, the increased risk for premature arthrosis has to be checked through a three-dimensional load on the joints. The joint adjustment in the sagittal profile is, in addition to the frontal plane (knock-knee), an especially decisive factor.(1, 16-18)

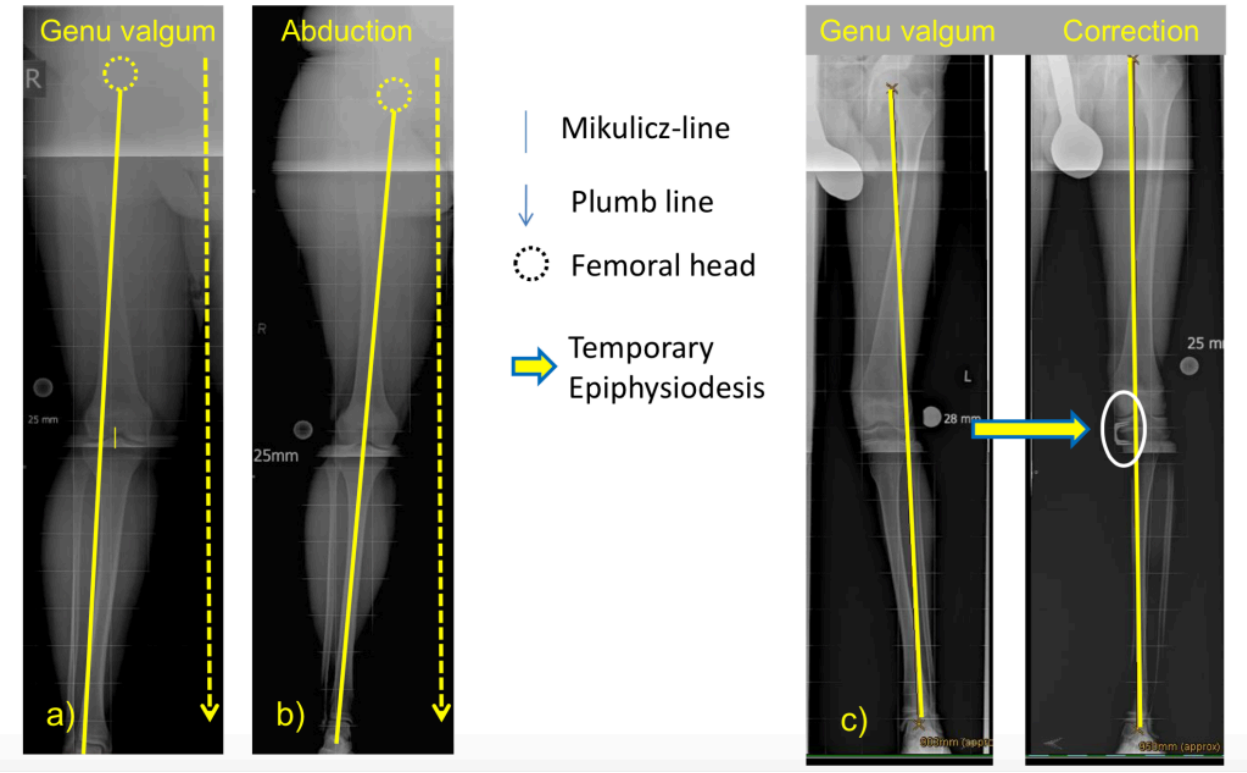

Figure 2

Flat foot (Pes abductoplanovalgus)

Probably the most common clinically diagnosed deformity in children who are obese is the flat foot (Pes abductoplanovalgus) with all of its aspects reaching to pes planus [Fig. 3 a: Pes valgus - Barefoot]. This is a mechanical overloading particularly of the medial foot structure, which often ends up deformed. However, the greater mid-foot contact surface is no longer sufficient to compensate for the patient's overweight. As the child grows, the mid foot is exposed to an increased loading stress due to the obesity. It is recommended that children with painful flat feet should participate mainly in non-weight-bearing activities such as swimming, cycling etc. in order to stay active while managing their weight. Only after losing some weight, should weight-bearing activities, such as running be increased.

It is still possible to strengthen the musculotendinous structures in growing children. As such, physiotherapy and insertion of a temporary orthotic may be useful to optimise the position of the foot during gait. If significant weight loss is not expected and if weight bearing physical activity is to be optimised, it may be necessary to prescribe custom orthotics for the adolescent. Children with diabetes mellitus especially require a large pressure distribution area to prevent early stage skin lesions from occurring. Such patients must be instructed from childhood on foot care to help prevent skin pressure problems in the long term.

The possibilities of surgical improvement of the foot's structure by means of Arthrorisis (other terms: Arthrorhisis or Arthroreisis) (temporary arthrodesis of the lower ankle joint) offer new options in the treatment of severe pes valgus. This is a small, low-risk procedure, which corrects the calcaneal valgus

and the characteristic of pes abductus by inserting a subtalar implant or stops screw in the subtalar joint space. The joint's surfaces are not touched, which means there is never any loss of mobility in the long term. The most effective treatment occurs during the years before the growth finishes (ages 10 -14, depending on the stage of development). [Fig. 3 b: Pes valgus – after arthroreisis (subtalar temporary arthrodesis with implant]. At this age, there are no other realistic conditions for a conservative corrective therapy, such that an alternative method to correcting calcaneal valgus does not exist. The Dwyer osteotomy is however available as an alternative surgical procedure that can be performed once the patient has finished growing.

As pes valgus also shares the same characteristics as pes abductus, this deformity has to be distinguished from the previously mentioned procedure. Pes abductus cannot be completely corrected by Arthrorisis. Alternatively, the calcaneal lengthening osteotomy (Evans osteotomy) is also available. However, the risks of this surgical procedure are much higher than in arthrorisis. Furthermore, this approach is only indicated once the patient has finished growing.

Simultaneous assessment of the entire leg axis should not be neglected, as genu valgum may exacerbate the symptoms of pes valgus. Under these circumstances, an orthopaedic examination is recommended between the ages of 10 and 12, as at this age the simple and low-risk corrective surgery of both pes valgus and knee-knocks, with arthroereisis and temporary epiphysiodesis respectively, is not delayed. (19-26)

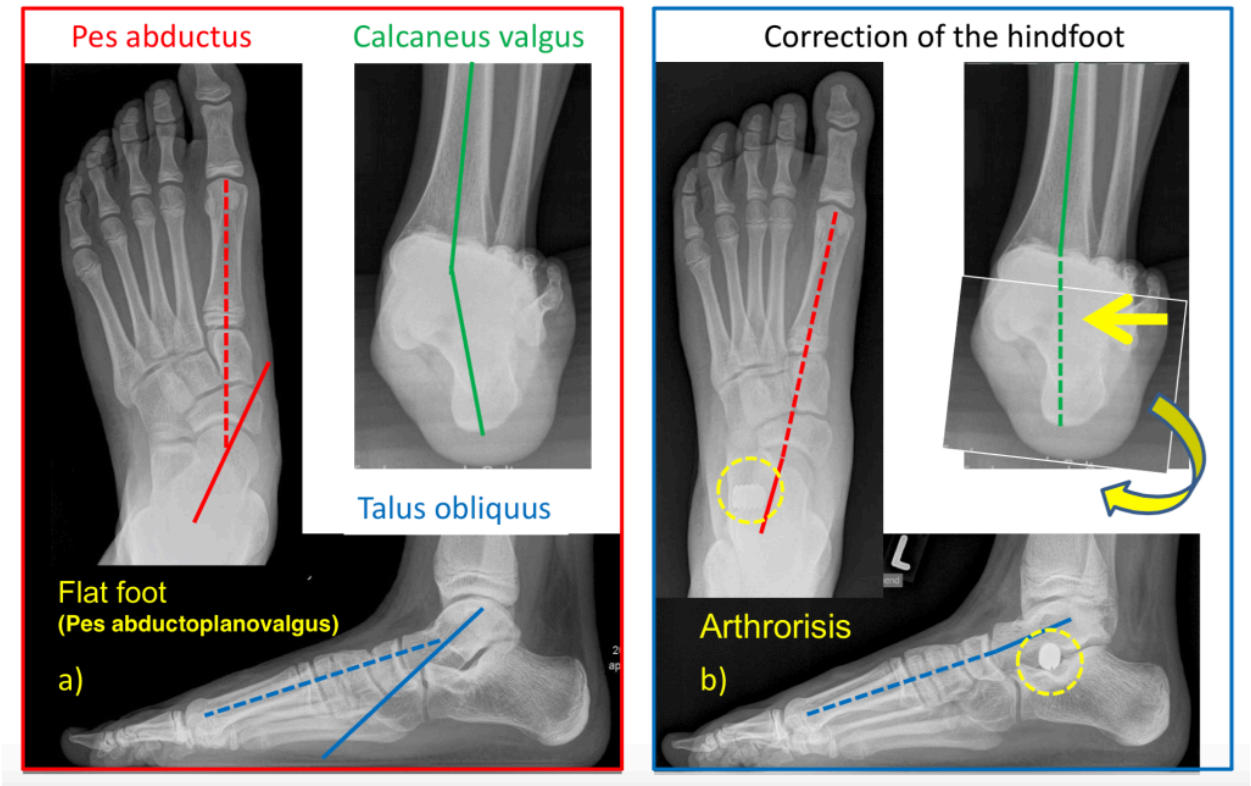

Figure 3

Sagittal profile

In the sagittal profile, spinal problems are by far the most common in obesity. In general, hyperlordosis of the lumbar vertebrae is the cause for lumbar discomfort. As abdominal girth increases, so too does the risk of hyperlordosis of the lumbar vertebrae, as well as lumbar discomfort and symptomatology. Muscular imbalance between the abdominal muscles and autochthonous muscles should be considered. The anatomical relationship between an upright posture and dorsal positioning of the spine, which causes, along with an abdominal distension, according to the lever-arm-law, a permanent strain on muscles of the back, particularly in obesity. Active physiotherapy to build muscular balance and core stability are paramount.

Long-term effects are symptomatic with ageing. A correlation between obesity and Scheuermann's disease is seen in clinical practice though recent literature does not describe this.
If the effects of the spinal adjustment to the lower extremities is investigated further, it is obvious that hyperlordosis of the lumbar vertebrae causes a tilt in the pelvis with shortening of the ventral hip flexors [Fig. 4a: Hyperlordosis of the lumbar spine, Fig. 4b: Scheuermann´s disease (lumbosacral hyperlordosis + Hyperkyphosis of the thoracal spine, Schmorl´s nodule)]. The resulting position, even if the knee flexion adjustment is only slight, is associated with an increased retropatellar load.

This is supported by clinical observations of frequent retropatellar complaints in children who are obese from an early age. If the increased retropatellar pressure is combined with genu valgum and with patellar lateralisation tendencies, then the retropatellar contact zone of the articular surface is reduced significantly and overloading is inevitable. Due to obesity, not only is there mechanical straining but also adverse hormonal factors affecting cartilage. It is obvious that, apart from correct axial alignment, weight loss would also affect the joints positively. Treatment is focused on physiotherapy and only in very rare cases surgical intervention becomes necessary. (1, 2, 27, 28)

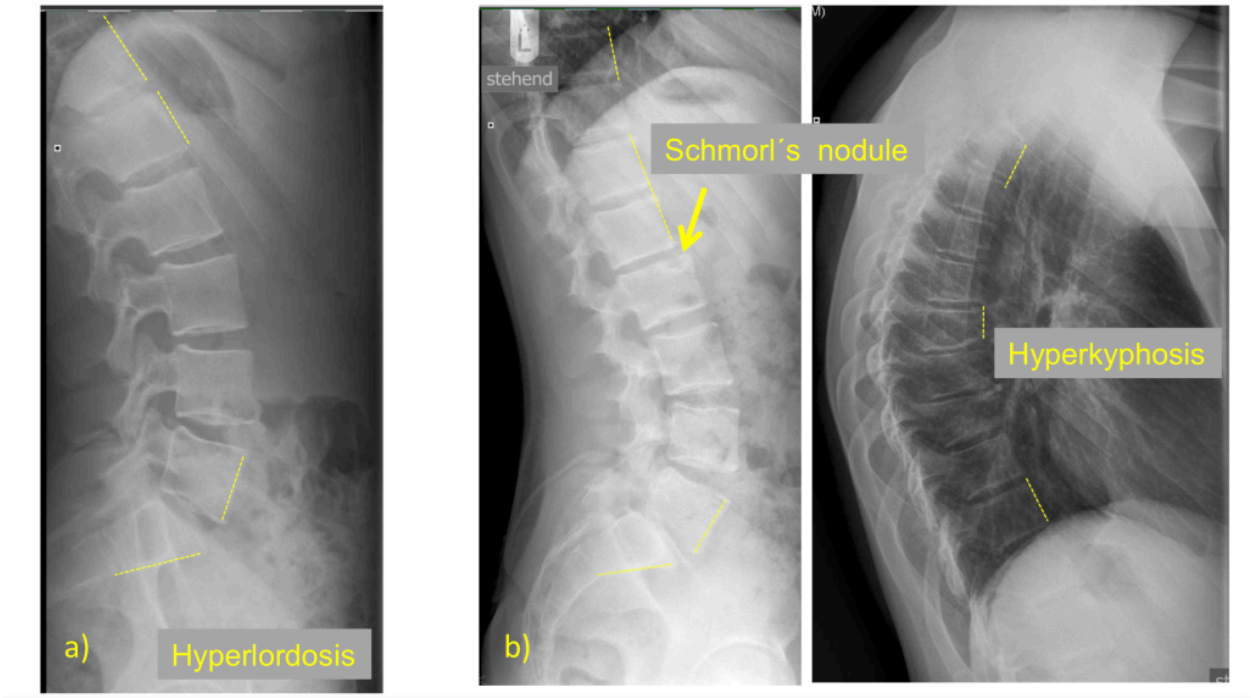

Figure 4

Osteopenia

Bone mineral density, bone mineral content and optimal bony architecture attained during childhood development are considered to be vital for the avoidance of osteoporotic fracture later in life, and specifically, the risk of osteoporosis is affected by the peak bone mass reached before 20 years of age. Adequate physical activity early in life may actually have an effect on bone into adulthood and help to create a 'bone-bank'(29, 30)

Due to suboptimal levels of health-enhancing physical activity, children who are obese and sedentary may present with reduced bone strength and thus may become osteopaenic, increasing the risk of fracture (31-33). Furthermore, peak fracture incidence occurs simultaneously with the growth spurt (12-14 years), and high indices of weight at this period of growth can affect bone's ability to cope with loading stresses. Independent predictors of recurrent fracture occurrence include: previous fracture, body weight, low bone mass, higher body mass index and lower levels of physical activity. In all cases, optimal nutrition for bone development should be encouraged through consumption of foods and drinks rich in calcium and vitamin D. In cases where bone health is compromised it may be necessary to screen for osteopaenia using DXA and physiotherapy intervention can have a good treatment effect (34, 35)}. In some cases vitamin D supplementation may also be warranted.

Outlook

In summary given the multiple adverse effects of obesity on the developing musculoskeletal system, initial clinical assessment should screen for relevant orthopaedic history, the presence of pain; and the

presence of gait or functional impairments. If assessment reveals difficulties with the musculoskeletal system an initial physiotherapy assessment is warranted. An orthopaedic examination should be sought at the beginning of adolescence so that there is time to proactively address bony complaints before growth has ceased. Special attention has to be paid to the leg axis, to the positioning of the feet and to the spinal column. Timely orthopaedic review is vital if potential arthroereisis (to correct the pes valgus) and a temporary epiphysiodesis (to correct the leg axis) are to be considered. These simple and low-risk procedures should be seen as an investment toward a less troubling orthopaedic future.

Summary

There are a number of orthopaedic conditions caused by childhood obesity, which are of particular importance. In early childhood, it is Perthes' disease and in adolescence slipped capital femoral epiphysis, both of which show a close correlation.

Leg axis and pes valgus foot deformities must be assessed by orthopaedic examination at the beginning of adolescence. This is the best time for examination as the musculoskeletal system can be corrected for the future through simple procedures (such as temporary epiphysiodesis and arthroereisis).

Spinal discomfort and the associated posture problems require physiotherapy. Physiotherapy forms the basis for symptom relieving actions, which are seen in an overall concept together with weight loss.

References

1. Taylor ED, Theim KR, Mirch MC, Ghorbani S, Tanofsky-Kraff M, Adler-Wailes DC, et al. Orthopedic complications of overweight in children and adolescents. Pediatrics. 2006;117(6):2167-74.
2. Krul M, van der Wouden JC, Schellevis FG, van Suijlekom-Smit LW, Koes BW. Musculoskeletal problems in overweight and obese children. Ann Fam Med. 2009;7(4):352-6.
3. Chan G, Chen CT. Musculoskeletal effects of obesity. Curr Opin Pediatr. 2009;21(1):65-70.
4. Widhalm HK, Seemann R, Hamboeck M, Mittlboeck M, Neuhold A, Friedrich K, et al. Osteoarthritis in morbidly obese children and adolescents, an age-matched controlled study. Knee Surg Sports Traumatol Arthrosc. 2014.
5. Wills M. Orthopedic complications of childhood obesity. Pediatr Phys Ther. 2004;16(4):230-5.
6. Lee JH, Zhou L, Kwon KS, Lee D, Park BH, Kim JR. Role of leptin in Legg-Calve-Perthes disease. J Orthop Res. 2013;31(10):1605-10.
7. Eckerwall G, Wingstrand H, Hagglund G, Karlberg J. Growth in 110 children with Legg-Calve-Perthes' disease: a longitudinal infancy childhood puberty growth model study. J Pediatr Orthop B. 1996;5(3):181-4.
8. Gettys FK, Jackson JB, Frick SL. Obesity in pediatric orthopaedics. Orthop Clin North Am. 2011;42(1):95-105, vii.
9. Witbreuk M, van Kemenade FJ, van der Sluijs JA, Jansma EP, Rotteveel J, van Royen BJ. Slipped capital femoral epiphysis and its association with endocrine, metabolic and chronic diseases: a systematic review of the literature. J Child Orthop. 2013;7(3):213-23.
10. Dendane MA, Amrani A, Abouqal R, Gourinda H, Ahid S. [Factors influencing the development of chondrolysis in children treated for slipped capital femoral epiphysis]. Arch Pediatr. 2014;21(8):821-6.
11. Scharfbillig RW, Jones S, Scutter S. Sever's disease: a prospective study of risk factors. J Am Podiatr Med Assoc. 2011;101(2):133-45.
12. Kose O. Do we really need radiographic assessment for the diagnosis of non-specific heel pain (calcaneal apophysitis) in children? Skeletal Radiol. 2010;39(4):359-61.
13. Shultz SP, D'Hondt E, Fink PW, Lenoir M, Hills AP. The effects of pediatric obesity on dynamic joint malalignment during gait. Clin Biomech (Bristol, Avon). 2014;29(7):835-8.
14. Guven A, Hancili S, Kuru LI. Obesity and increasing rate of infantile blount disease. Clin Pediatr (Phila). 2014;53(6):539-43.
15. O'Malley G, Hussey J, Roche E. A pilot study to profile the lower limb musculoskeletal health in children with obesity. Pediatr Phys Ther. 2012;24(3):292-8.
16. Landauer F, Huber G, Paulmichl K, O'Malley G, Mangge H, Weghuber D. Timely diagnosis of malalignment of the distal extremities is crucial in morbidly obese juveniles. Obesity facts. 2013;6(6):542-51.
17. de Sa Pinto AL, de Barros Holanda PM, Radu AS, Villares SM, Lima FR. Musculoskeletal findings in obese children. J Paediatr Child Health. 2006;42(6):341-4.
18. Shultz SP, Sitler MR, Tierney RT, Hillstrom HJ, Song J. Effects of pediatric obesity on joint kinematics and kinetics during 2 walking cadences. Arch Phys Med Rehabil. 2009;90(12):2146-54.
19. Shultz SP, Sitler MR, Tierney RT, Hillstrom HJ, Song J. Consequences of pediatric obesity on the foot and ankle complex. J Am Podiatr Med Assoc. 2012;102(1):5-12.
20. Mauch M, Grau S, Krauss I, Maiwald C, Horstmann T. Foot morphology of normal, underweight and overweight children. Int J Obes (Lond). 2008;32(7):1068-75.

21. Mickle KJ, Steele JR, Munro BJ. Does excess mass affect plantar pressure in young children? Int J Pediatr Obes. 2006;1(3):183-8.
22. Mickle KJ, Steele JR, Munro BJ. The feet of overweight and obese young children: are they flat or fat? Obesity. 2006;14(11):1949-53.
23. Evans AM, Rome K. A Cochrane review of the evidence for non-surgical interventions for flexible pediatric flat feet. Eur J Phys Rehabil Med. 2011;47(1):69-89.
24. Taisa Filippin N, de Almeida Bacarin T, Lobo da Costa PH. Comparison of static footprints and pedobarography in obese and non-obese children. Foot Ankle Int. 2008;29(11):1141-4.
25. Morrison SC, Durward BR, Watt GF, Donaldson MD. Anthropometric foot structure of peripubescent children with excessive versus normal body mass: a cross-sectional study. J Am Podiatr Med Assoc. 2007;97(5):366-70.
26. Richter M, Zech S. Arthrorisis with calcaneostop screw in children corrects Talo-1st Metatarsal-Index (TMT-Index). Foot Ankle Surg. 2013;19(2):91-5.
27. Deere KC, Clinch J, Holliday K, McBeth J, Crawley EM, Sayers A, et al. Obesity is a risk factor for musculoskeletal pain in adolescents: Findings from a population-based cohort. Pain (03043959). 2012;153(9):1932-8.
28. Palazzo C, Sailhan F, Revel M. Scheuermann's disease: an update. Joint Bone Spine. 2014;81(3):209-14.
29. Bailey DA, McKay HA, Mirwald RL, Crocker PR, Faulkner RA. A six-year longitudinal study of the relationship of physical activity to bone mineral accrual in growing children: the university of Saskatchewan bone mineral accrual study. J Bone Miner Res. 1999;14(10):1672-9.
30. Bass S, Pearce G, Bradney M, Hendrich E, Delmas PD, Harding A, et al. Exercise before puberty may confer residual benefits in bone density in adulthood: studies in active prepubertal and retired female gymnasts. J Bone Miner Res. 1998;13(3):500-7.
31. Goulding A, Jones IE, Taylor RW, Williams SM, Manning PJ. Bone mineral density and body composition in boys with distal forearm fractures: a dual-energy x-ray absorptiometry study. J Pediatr. 2001;139(4):509-15.
32. Goulding A, Taylor RW, Jones IE, McAuley KA, Manning PJ, Williams SM. Overweight and obese children have low bone mass and area for their weight. Int J Obes Relat Metab Disord. 2000;24(5):627-32.
33. Goulding A, Grant AM, Williams SM. Bone and body composition of children and adolescents with repeated forearm fractures. J Bone Miner Res. 2005;20(12):2090-6.
34. Nichols DL, Sanborn CF, Love AM. Resistance training and bone mineral density in adolescent females. J Pediatr. 2001;139(4):494-500.
35. Van Brussel M, Takken T, Uiterwaal CS, Pruijs HJ, Van der Net J, Helders PJ, et al. Physical training in children with osteogenesis imperfecta. J Pediatr. 2008;152(1):111-6, 6.e1.

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