Medial Rotation Gait

Particular Cause: Acetabular Anteversion

by D. Pomarino, F. Kühl, A. Pomarino

Introduction

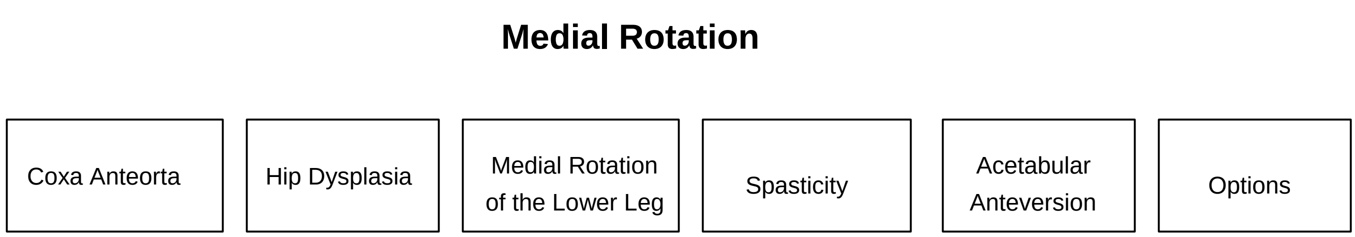
Medial rotation (or internal rotation) is a frequently occurring variant of gait in children. Up to date, there is however no findings on its incidence, probably because differentiations about its possible causes have not yet been applied. Up to the age of four, medial rotation would basically be physiological if anamnesis has shown that spasticity and hip dysplasia could be excluded.

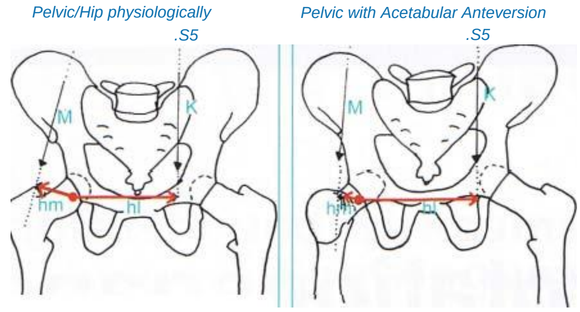
After this life stage, a different transmission of force is applied to the pelvis through a wrong position of the skeletal apparatus. Medial rotation is possibly caused by a coxa antetorta. Coxa anteorta occurs in children, during the age of growth, and is one of the most frequent reasons for the so-called antetorsion syndrome. The ante torsion ankle of four-year olds is 28 deg, those with a coxa antetorta usually have 48 deg. This anteversion relates exclusively to the tight and is therefore femoral. Visible symptoms are an uncommon gait pattern with knees bend outward.

Concerning hip dysplasia, no causes have been sufficiently verified yet, but a family disposition may play a significant role here. Already during the embryonic stage, the acetabulum is not developing and a positioning of the femoral neck into the hip is not taking place. This is indicated in infants by the obstruction of hip abduction, a pelvic asymmetry, and a hip sonography. These infants may be treated by splints, which are positioned in a certain way so as to use pressure to push the femoral neck into the acetabulum.

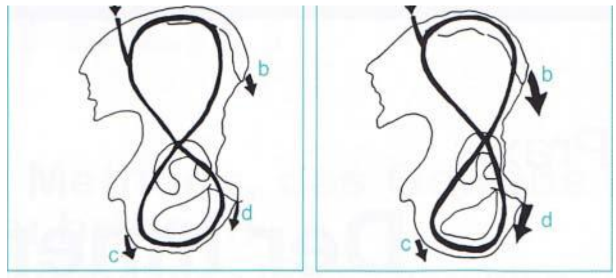
Frequently, an additional physiotherapy is administered. In case the hip dysplasia is too far developed, the application time of the therapy too short or imperfect, damages of the acetabulum and the femur neck will remain, because they are not able to develop congruent articular surfaces. One of the most severely occurring damages would be the luxation of the hip towards latero-cranial. If the articular surfaces have been developed in a way so as to support the hip, they would adapt to the given environment. This may bring about medial rotation. Another cause could be the medial rotation of the lower leg. In this case there would be no defective position proximal to the knee joint. Medial rotation takes place immediately between femoral condyle and tibial plateau. This can also result in medial rotation.

Fig. 1: Causes of medial rotation





hm = lever arm of a force of hip abductors
hl = load arm of weight
M = pull of muscles
S5 = balance point shifted to supporting leg
K = weight



a = transmission of force from the spinal column
b = force on femoral extensions
c = force on femoral flexors
d = force on adductors

Fig. 2: Pelvic leverage mechanism – on the left, physiologic leverages during hip abduction; on the right, changing forces during abduction in case of acetabular anteversion.

Fig. 3: Transmission of force at pelvis laterally — picture showing the pelvis while standing.

In case of spasticity, orthopedic components are exceeded, and neurological aspects come into play. Due to this fact and because of its greater complexity, this very form of medial rotation differs considerably from other variants of the same defection. The diagnosis of medial rotation gait patterns utilizes clinic and radiological checks and works according to the method of exclusion. Once this has been done, and the medial rotation has not been cured, new considerations become inevitable. Acetabular anteversion can be thought of as an optional healing method. The still prevalent lateral and ventral wall of the femur head in children suggests applying this approach as well. Through biomechanical and static changes, the acetabulum turns into a detrimental position causing medial rotation of the femur, as will be shown in the following.

Anatomy and Biomechanics

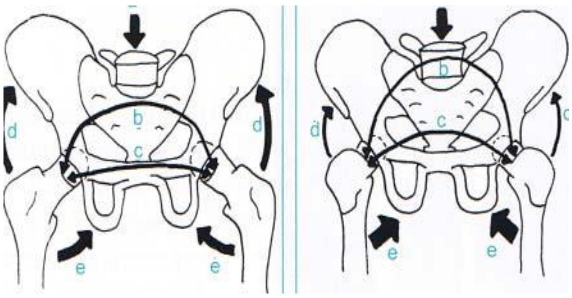
Considerations regarding medial rotation result in the following findings: medial rotation would be a non-physiologic defection with the acetabular anteversion towards ventral, if the child has exceeded the fifth birthday. In this case, a centering of the hip can only be accomplished if the femur head turns to the inside, bringing about a medial rotation of the entire leg.

From a functional perspective, there is no deviation of axis or deformation of the legs; rather, they are turned towards medial.

As a result of this alteration, the pelvis is positioned into a vertex presentation, in order to render a centering of the hip possible. The large femoral neck-shaft angle in children and adolescence is encouraging this, and muscles and ligaments are adapting to the new situation. Through an enduring position of dilation, the hip abductors and external rotators are loosing their momentum of force, causing a long term insufficiency of this group of muscles. Its function as stabilizer of the pelvis and transmission of force, particularly the tractus iliotibialis, is affected. Moreover, the approximation of the adductors and medial rotators prevents the two antagonists from being in balance.

Leverages around Pelvis and Hip

In a physiologic abduction, the load arm of weight is relatively long. In contract, the lever arm of force in hip abduction is relatively short (Fig. 2, left). The pull of the muscle is determined by the base of the origin of the hip musculature. Balance point and weight shift towards the contra-lateral side of the supporting leg. In case of the abduction of a patient with acetabular anteversion, the trochanter, as the base of the hip abductors, is no longer lateral but has shifted towards medial (Fig. 2, right). Through this approximation of trochanter and acetabulum, the lever arm of force of hip abductors is reduced in length, preventing them from functioning properly. The enduring position of dilation brings about an insufficiency of this group of muscles. Now, their antagonists, hip abductors and medial rotators, are dominating functionally.



a = transmission of load from the pelvis
b = force path via the pelvic ring
c = force of path via the pelvic ring
d = hip abductors
e = hip abductors

Fig. 4: Schematic graph of force transmission at the pelvis while standing.

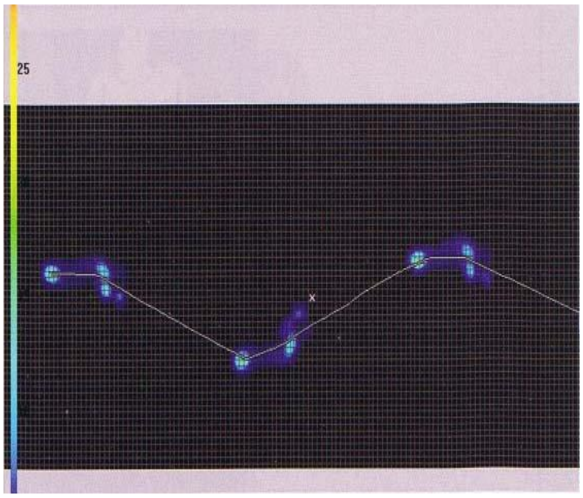


Fig. 5: Schematic graph of foot trace of a patient with medial rotation gait. Measurement carried out with pressure-measuring disk.

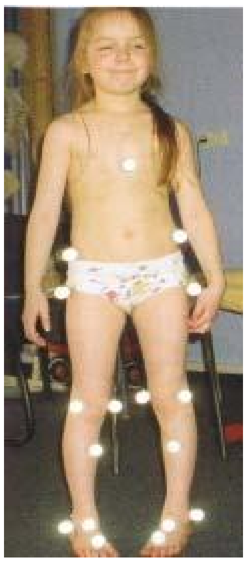
Transmission of Force in the Pelvic Region

The physiologic transmission of force in vertical position in os coxae runs from lateral describing a rollercoaster tour (Fig. 3, left). The arches run proximal through the crista iliaca, and distal through the tuber ischiadicum. In the center, where the forces are strongest, is the acetabulum. The strongest forces of the pelvic region account for the stronger and thicker build of the bones there, compared with areas with no forces running. The force is transmitted directly onto the femoral diaphysis, and the center of the mentioned arch-shaped course with its adjoining forces is shifted ventrally through the acetabular anteversion. The arch-shaped courses of the forces remain with the crista iliaca and the tuber ischiadicum. The best developed osseous region of the pelvis is the acetabulum, which is actually meant to absorb occurring forces. Because of it relocation, these forces are now to affect the osseous areas. Side effects may occur and even result in pathologic alterations.

Looking ventrally (Fig. 4): coming from the lumbar spine, the forces are transmitted to the sacrum. In case of proper gait, they will then be directed laterally via the iliac wings and the os pubicum acetabulum. The femoral diaphysis absorbs the major part of force, and a smaller part is taken charge of by the hip abductors and adductors.

Acetabular Anteversion: Diagnosis in Practice

Looking ventrally, it shows that an acetabular anteversion from the different position of the trochanter towards each other results in an alteration of forces applied. Through the tilting of the hip towards proximal into the hypogastrium, the ventral transmission of force is changing its base and the dorsalis is shifted proximally towards the fourth and fifth lumbar vertebrae. The distribution of the major force is now no longer located in the region of the stabilized pelvis, but in the area of the spinal column. Though the new center of force-distribution is charged with the forwarding processes in the trunk, it is not supposed to be the focal point of all the forces that arrive from the upper part of the body. In order to counterbalance this shift of forces, patients may suffer from a hyperlordosis of the lumbar spine.



Movement Analysis

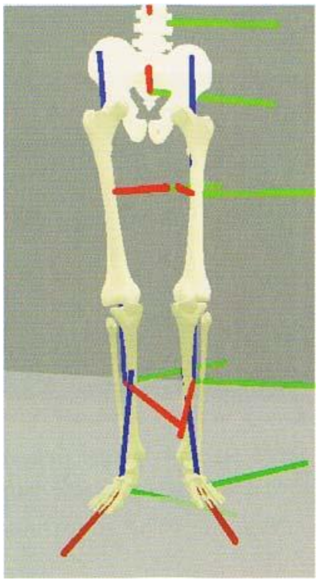


Fig. 6: Provision of a three-dimensional view of the patient's lower extremities during the first consultation.

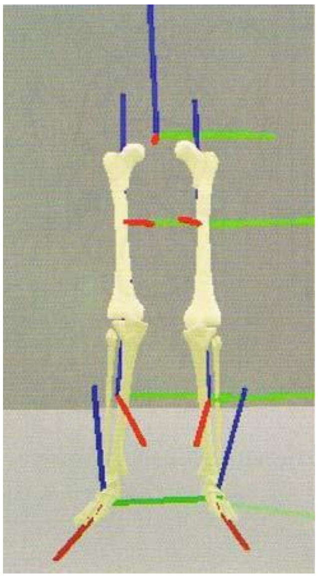


Fig. 7: Provision of a three-dimensional view of the patient's lower extremities after application of Torgheel heels.

Presumptive Causes

Presumably, a certain disposition regarding the acetabular anteversion is congenital. The physiologic pressure that is permanently affecting the acetabulum results from the acetabulum's position provided; and the acetabulum itself is, because additionally fostered through the still immature osseous structure, further and increasingly shifting ventrally.

Possible Secondary Diseases

Considering this, the hip joint would have bee exposed to a long term and permanently increasing pressure. The situation would redirect the high pressure towards the labrum posterior and the fascies lunata, whose build is actually not meant to bear this additional stress. Possibly resulting secondary diseases may be a coxarthrosis and local chronic pains. Through these biomechanical alterations, the adjoining joints, such as the knee joint, would have been affected as well. Thus non-physiologic behavior may result in a not quite correct application of pressure, which effectuates a degeneration of the meniscus.
Because of the different way of walking in patients with medial rotation gait, disturbances of both motoric coordination and imbalances are likely to occur. The stumbling upon one's own feet is a typical phenomenon in these patients. Affected children often complain about pains, which are probably due to a inguinal compression, a hyperlordosis in the lumbar spine, or the shears that develop around the knee.

Diagnostics

A diagnosis can be made by using the three-dimensional movement analysis, or gait analysis, which enables a 3D-picturing showing the skeletal apparatus, through utilizing inverse kinematics.
Besides, a force-measuring disk is applied to measure the transmissions at work (Fig. 5).

Case Study

A seven year-old patient consulted the practice in February 2005; he was diagnosed a medial rotation gait. This gait pattern has existed since the child has acquired walking. Through radiological and sonographical examinations, deviations of the ante torsion ankle at the femur and a hip dysplasia could be excluded. A three-dimensional movement analysis, however, indicated an axial deviation of the right leg (Fig. 5). The examination findings suggested a limitation of movement regarding hip extension and hip abduction, and it also indicated a pain provocation while moving. The child has a significant deviation in a hyperlordosis of 35 deg.
Over a period of 24 weeks, the patient has been provided with physiotherapy and Torgheel heels, stimulating an external rotation of the leg. Medial rotation gait patterns in the patient have disappeared completely after this time of treatment and have not been re-occurred after another six months. A check of the study with another three-dimensional analysis shows the axial changes. The hyperlordosis has also been enhanced considerably to about 8 deg.

Discussion

A treatment of medial rotation gait patterns in children helps reduce possibly occurring complications of the hip, pains, and coxarthrosis in adult years. The alterations that medial rotation entails, do not only affect the hip, but also the entirety of the skeletal muscles in a negative way.

Treatments that utilize Torgheel heels and therapeutic exercises are actually effective, fast, and cost-saving methods to cure medial rotation. A movement analysis alone is however not appropriate for finding out whether there has any 'reshaping' of the acetabulum taken place. The employment of a nuclear magnetic resonance imaging (NMRI) to bring the causes to light seems obvious at first sight; but NMRI administered to children means general anesthesia and is therefore hardly justifiable.
To sum, secondary diseases of the spinal column, feet, hip, or knee can be avoided. However, this would require a highly-recommended treatment of these patients by means of Torgheel heels and therapeutic exercises.

Authors:

David Pomarino
Frederike Kühl (Lead, Department of Physiotherapy) Dr. med. Andrea Pomarino Physiotherapiezentrum Pomarino
Eulenkrugstrasse / Wiesenhöfen 55-57
22359 Hamburg
Tel.: 040/ 87 88 50 71
info@ptz-pomarino.de, www.ptz-pomarino.de

Literature

Buckup K. Kinderorthopädie. Stuttgart: Thieme Verlagsgruppe, 2001.
Heft F. Kinderorthopädie in der Praxis. Basel: Springer
Verlag 2006.
Hahn von Dorsche H, Dittel R. Anatomie des Bewegungssystems. Bad Hersfeld: Neuromedizin Verlag 2005.

Acknowledgement

We would like to thank Prof. Dr. med. habil. Herwig Hahn von Dorsche, for his excellent personal mentoring and his helpful generosity to share his expert knowledge. Thank you very much.