Motor development of a child in the first three months of life

A – preparing concepts
B – formulating methods
C – conducting research
D – processing results
E – interpretation and conclusions
F – editing the final version

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Abstract

The standards as to when children should acquire particular gross and fine motor skills were presented in that study. Proper motor development of children may affect all aspects of their lives. Early detection and diagnosis of abnormalities make it possible to cope with developmental disorders quickly.

The functioning of children changes in the first year of their lives. Children gain indispensable experience from the surrounding world and learn to react to external stimuli. They also develop their patterns of behavior and improve perception. This work focuses on selected aspects of motor development that play a significant role in the process of physiotherapy aimed at infants in their first trimester.

Key words: **infant, motor skills, movement pattern, motor development**

Introduction

Motor development of a healthy child involves the acquisition of new motor skills. Proper development may occur in a different manner in each child. However, there are some standards as to when children should acquire particular gross and fine motor skills. Proper motor development of children may affect all aspects of their lives. Early detection and diagnosis of abnormalities make it possible to cope with developmental disorders quickly [1]. The functioning of children changes in the first year of their lives. Children gain indispensable experience from the surrounding world and learn to react to external stimuli. They also develop their patterns of behaviour and improve perception [2].

This work focuses on selected aspects of motor development that play a significant role in the process of physiotherapy aimed at infants in their first trimester.

Neonatal period – the first month of life

Upon birth, safe and comfortable conditions that a neonate had in the uterus are replaced with a completely different environment. Movements experienced during 40 weeks of pregnancy are difficult to perform due to the lack of the skill of active work against gravity. The lack of head and trunk control means the baby is completely dependent on their caregivers3]. Over the next months, the baby develops motor skills, and along with the development of postural tone, their stability and mobility improve. As a result, the baby learns to pull up to a standing position and to move around independently [4]. As for the body posture, the tension of flexors dominates, while slight abduction can be noted in proximal joints of the limbs. We can notice numerous and barely coordinated movements that help the baby to oppose gravity. In the first month of life, the baby, when in a prone position,

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keeps the head to the side and supports oneself on cheeks, the thenar eminence, shoulder joints and medial parts of knee joints. The baby lifts the head for a while in order to put it down on the other side. Upper limbs are placed below the chest. In a supine position, the flexion is particularly noticeable in hip and elbow joints as well as in the feet. The head is positioned asymmetrically and, similar to the prone position, the body weight is placed on the cheek.

Due to the lack of skill of dissociation between the neck and the trunk as well as increased tension of flexors, head twist in the opposite direction sometimes results in the child being turned to the side. This reaction (tonic neck reflex) is less evident in flaccid children [5].

Together with the development, i.e. with gaining sensorimotor experience, developing basic posture and movement patterns as well as the central nervous system maturation, the use of tonic posture reflexes to stabilise and control the body decreases. It is replaced with extension reactions and with developing balance reactions [6,7].

During a pull-to-sit test, the baby cannot support their head yet and their facial expression changes, i.e. focus and distress can be noted, while sternocleidomastoid muscles are contracted on both sides.

In a sitting position, the baby tries to raise their head, which quickly falls, the chin rests on the chest and neck extensors are not active. The spine is rounded, while the erector spinae muscles are stretched. Hip joints are flexed, abducted and externally rotated, knee joints are slightly flexed, while feet are in dorsiflexion.

In supported standing, the baby bares body weight as the support reaction evoked in this manner causes an increase in tonic muscle contraction in lower limbs. Due to the flexion tonus dominating the position at birth (caused, inter alia, by the contraction of soft tissues surrounding the joints), full extension in the knee joints does not occur and hip joints are also slightly flexed and externally rotated. Feet are held close to each other or even crossed in dorsiflexion and pronation.

In a vertical position with an inclination forward, an intermittent pattern of lower limb movement imitating the gait is noted. A simultaneous flexion in all the joints of lower limbs is noted with body weight shifted forward. When the foot touches the surface, the joints of the same limb are simultaneously extended. It is called "automatic gait", present only for the first few weeks of life [8].

A newborn and a young infant receive signals from the surroundings mainly through touch. In the first month of life, it is a "fight-or-flight" response. The baby does not recognise shapes or textures; however, they can recognise what type of stimulus is pleasant and which is associated with pain or the loss of security. With time, the senses of vision and hearing are becoming more and more important. In the first month of life, the baby can notice an object with contrasting colours [9], see single fragments of an image and recognise the light and turn the head towards it. A newborn cannot isolate the movement of eyes from the head movement. In order to focus the eyes on an object, the head must be stabilised in a particular position.

The second month of life

In the second month of life, children are more "vigilant", more alert to signals from their surroundings and clearly interested in people interacting with them. There appears the so-called social smile. Together with the adaptation to new conditions (gravity), an infant activates extensor muscles influencing the elongation of flexors. The physiological dominance of flexion gradually changes into harmonious cooperation with postural extensors. Due to the tension of flexors lower than in the first weeks of life, the child seems to have more chaotic movements and this period is called semi-hypotonia by some researchers [10].

While lying flat in a supine position, the child can hold the head in a median line of the body for a short time. However, due to weak trunk stability, the head mainly leans to one side.

Children learn to follow an object with their eyes at the same time training their visual perception. They can follow an object through a 90-degree angle. The development of ocular muscle control and an improvement in the perception abilities are closely related to the development of midaxillary body line orientation and the ability to control the head along the body axis [5]. The use of the sense of sight is a significant factor determining further development of children as it motivates them to initiate subsequent motor activities [11].

In the second month of life, motor abilities are influenced by the asymmetrical tonic neck reflex (ATNR) [12]. In a healthy child, motor response to the turn of the head is never the same. Limbs on the side towards which the face is turned manifest more

extensor activity, while on the other side, flexion is dominant. Due to such a distribution of muscle tonus, children have an opportunity to improve visual-motor coordination and fine motor skills controlled by the sense of sight. Turning the head to the other side changes the pattern (from flexion to extension and the other way around), which constitutes the first experiences related to body weight transfer, alternate muscle work and dissociation between the shoulder and pelvic girdles in the coronal plane. The ATNR position also makes it possible to gain experience in separate work of limbs on both sides of the body and it activates multidimensional work of the pelvis.

Turning one's head to the side is sometimes accompanied by turning the whole body to the same side. Such a movement pattern is caused by low stability of the spine in the transverse plane, low-quality dissociation between particular vertebrae and the influence of tonic neck reflex on movement patterns. During a pull-to-sit test, due to the lack of control of neck flexors, the child cannot raise their head however the contraction of elbow flexors as a response to the pull-to-sit movement is clearly visible.

In a sitting position, the back is still rounded and the first attempts at contracting extensor muscles in order to hold the head along the body axis are observed [13]. In a standing test in the second month of life, the baby does not bear weight on their feet (astasia) and the spine remains bent [5].

Due to the flexion in hip joints, the shoulder girdle is more forward than the pelvis girdle, which is similar to the first month of life. Toes are bent, which helps the baby to stabilise lower limbs in a forced vertical position.

The activity of spine and neck extensor muscles increases gradually. As a result, the baby lying in a prone position holds the head up higher and higher, even at a 45-degree angle. The head can be held up for a few seconds. Due to a increased mobility of the cervical spine, while turning the head, the baby can support their head on their ear versus the cheek observed in the first month of life. Their center of gravity gradually moves towards the pelvis, which enables the movement of scapulae in the chest and positioning their anterior angles closer to the spine. The baby frees upper limbs from under the chest and moves them a little forward. Due to an insufficient quality of stability control in the shoulder girdle area, elbow joints are more backwards than shoulder joints, the humerus is abducted, extended and internally rotated. The baby makes the first attempts at supporting the body on forearms, pushes against the surface at the same time freeing arms gradually and initiates activity related to fine motor skills. When the head is raised, body weight is mainly supported by the chest. The child also begins to push against the surface with their knees. Raising the head from above the surface and extending the trunk initially stretches the front chest muscles and rectus abdominis muscle but, due to the lack of the possibility of extending them fully, immediately shortens them leading to the hip joint flexion. Although lower limb joints are still dominated by flexion patterns, increased extensor activity occurs. Symmetrical work of hip extensor muscles which is initiated in this period is an indispensable condition for future stability of the position while raising one's head or extending the trunk.

The third month of life

A three-month-old baby is interested in the surrounding world, interacts with guardians and follows toys with their eyes through 180-degree angle. In this period, the baby improves the skills of head control and limb coordination against gravity. Also, the pace at which median body axis orientation and body awareness are shaped increases. The baby puts both hands into the mouth, holds a toy, grabs clothes or touches one's own body, i.e. the grabbing reaction does not dominate in movements any more [7].

While lying in a supine position, the baby holds the head mainly along the median axis of the body, supports the chin on the chest and activates neck flexor muscles in the symmetrical work. Due to the ability to balance the work of antagonist and agonist muscles, the baby does not need to have the body position stabilised with a position of limbs forced in ATNR. Because of an incomplete mobility of the cervical spine and under the influence of the tonic neck reflex which extends the trunk, the baby turns the whole body when the head is turned to the side. However, due to the lack of the possibility of abducting arms to a larger extent, the rotating movement is slightly hampered. The baby joins hands in the body axis, raises the forearms above the surface and more and more often watches one's

own hands focusing the eyes on the median body axis. Owing to the ability to stabilise the position by controlling the shoulder girdle, the baby is capable of moving the pelvis in the sagittal plane, i.e. the pelvis can be moved upwards. Both shoulder and elbow joints are more and more often extended. As a result, the baby gradually holds the hands closer to the raised lower limbs and touches thighs. The baby can kick intermittently until the legs are extended in hip and knee joints, with the feet in an intermediary position. Trunk stability and head control along the median body axis in this period enable the antigravity work of limbs. While at rest, lower limbs are symmetrically flexed in the area of hip joints and knee joints, while feet are in dorsiflexion. Feet are joined, the baby rubs one foot with another at the same time improving the sense of touch and preparing the limbs to bear weight [6].

While lying in a prone position, the baby can actively support the body on forearms by pushing against the surface. Owing to the cooperation between flexors and extensors, the baby raises the chest from the surface and controls the head in the body axis at the same time focusing their eyes parallel to the surface. Elbow joints are in the same line as shoulder joints, while forearms are supine, which makes it possible to move the fulcrum from the thenar to the hypothenar. Thus, the hands are ready for the development of manipulation and grabbing. The baby intermittently extends and flexes fingers "scratching" the surface and grabbing the blanket. While turning the head to the side and with the flexion in the shoulder joint above 90 degrees, the baby moves the body mass to this side. In this manner, the baby gains wider experience in balancing body mass in the trunk area with simultaneous dissociation in the area of upper and lower limbs. A lower limb on the weight-bearing side is extended, while the limb on the non-weight-bearing side is flexed in all joints and is more abducted. While lying in a prone position, the baby learns to kick intermittently while dissociating the pelvis in the coronal and transverse planes and learning the separate work of lower limbs. The baby gradually extends the limbs in the knee and hip joints, the stabilised pelvis more often lies on the surface and toes are positioned on the surface, which affects the baby's further ability to work actively in the feet area while bearing weight on the legs.

Although a three-month baby can control the head in the median body axis while lying in prone and supine positions, the head still does not follow the movement during a pull-to-sit test. It is particularly visible in the initial range of movement. The closer the vertical position, the easier it is for the baby to contract both sides of oblique abdominal muscles, activate neck flexor muscles and hold the head in the spine axis. Owing to the contraction of abdominal muscles and activation of hip flexors, it is possible to stabilise the chest, which, in turn, determines the head control during a pull-to-sit test. Despite a good head stability in the median body axis in a supine position, neck muscles are still not active enough to hold the head in symmetry in the antigravity position. Thus, during a pull-to-sit test, the head is often turned to one side.

In the position of supported sitting, hyperextension in the position of head is no longer noted. It results from an improvement in the control of the shoulder and pelvic girdles relative to each other and from increasing activation of neck muscles. The spine is no longer so curved as in the previous months of life, while body weight is born on ischial tuberosities. Astasia observed in the second month of life is no longer present. The baby supports the weight on the whole feet, sometimes flexing the toes as a result of proprioceptive stimulation when the feet touch the surface. An increase in the distal tonus evoked in this manner facilitates proximal stability, i.e. the trunk control. Extension tonus in knee joints and a slight abduction in hip joints also help the baby to control the standing position. The baby supported in the area of upper ribs can hold the head in the median body axis. In order to stabilise the position, the baby makes use of the ability to modify the tonus in upper limbs. The weaker the trunk control, the higher the extension tonus in elbow joints.

The fourth month of life

Synchronization of the flexors and extensors while lying in a prone or supine position, which has been prepared in the previous months of life, now enables the baby to develop further towards moving independently, grabbing toys, examining the surroundings or getting to know oneself. The baby improves their motor coordination, self-agency and motivation. Owing to the ability to control the head and trunk along the symmetry axis and the ability to perform intermittent limb work as well as the ability to control the pelvis in the sagittal plane in the fourth month of life, the baby develops coordination of both sides of the body in the work against gravity.

While lying in a supine position, the baby holds the head along the median body axis, pulls the chin towards the chest and joins hands above the chest. While maintaining hip joints in a flexed position and elbow joints in an extended position, the baby reaches for calves and feet. Symmetric antigravity work of limbs close to the median body axis is particularly significant in this period. While holding the hands supported on the calves, the baby can turn to the sides. Owing to this position, the baby can gain new sensorimotor (i.e. sensory, vestibular or proprioceptive) experience and develops the auditory and visual perception, which, in turn, affects the development of extension reactions and controlling the position of lying on one's side. The quality of postural control in this position depends to a large extent on the ability to balance the work of trunk, head and neck flexors and extensors which was shaped in the previous development periods. While lying in a supine position, the baby can follow a toy with eyes only without moving the head. Owing to the ability to stabilise the head together with extensor muscle elongation, a baby can look down towards lower limbs, which helps to control the body with sight. The presence of the neck tonic reflex is still clearly visible and while turning the head following a stimulus, the baby turns the whole body en-bloc. Turning to the side may also occur as a result of dissociation between upper limbs when one limb remains flexed and the other one is flexed in the hip joint and extended in the knee joint. Body weight is moved the side of the trunk in the direction of the rotation and the baby rolls to one side. It is an ability to rotate with an active transfer of body weight to the elongated body side with the use of limb dissociation that is improved during the few months [14].

An increase in the tonus of extensor muscles which occurs in the fourth month of life is particularly visible when the baby is lying in a prone position. The development of the tonus of neck and trunk extensors makes it possible to improve the stability of the shoulder girdle, to hold the chest up higher above the surface and to shift the center of mass gradually towards lower limbs, which improves the quality of pelvis stability and hip extensors activation. The baby actively bears body weight by supporting oneself on the forearms, elbow joints are before the shoulder line, the head is held up at a 90-degree angle. The muscle extensor tonus which dominates in this period stimulates the development of the vestibular system which is jointly responsible for the development of visual perception. While turning the head to the side, the baby shifts body weight to the same side which makes it impossible, at this development stage, to reach for a toy under visual control and it slightly shortens the weight-bearing side of the trunk. It is the so-called primitive body weight shift which does not happen in the next few months following this point of life [5]. While lying in a prone position and supporting the body actively with one's forearms, the baby is able to bend the head and look down without losing balance. Such a posture control is possible owing to the ability to coordinate the work of flexors and extensors. Lying in a prone position, the baby can also draw back one's hand behind the shoulder line, move the scapulae closer to the spine and raise the body thus presenting the extensor pattern.

It is possible that in a position supported on one's forearms, when body weight is shifted to one side and stability in the shoulder girdle is still not sufficient, there occurs adduction of the arm to the chest and a turn to the position of lying on one's side or even the whole turn from a prone position to a supine position.

In a horizontal suspension position, due to the tension of spinal erector, activation of the vestibular system and the effects of optical-labyrinth reaction providing a stimulus to raise the head, the baby brings the scapulae closer and contracts extensor muscles in the thoracic spine. It is called the Landau reflex, which is observed in previous and next months of life and which changes in time.

During a pull-to-sit test, the baby actively participates in the task. By focusing eyes on the examiner, the baby initiates the movement of pulling up by protruding the chin (by contracting neck flexors) and contracting upper limb flexors. Afterwards, the baby stabilises the head by activating the shoulder girdle and contracting neck extensors. Symmetrical work of abdominal muscles leads to the flexion of lower limbs in hip joints.

A 4-month-old baby can sit with support for a few seconds. Head and neck extensors stabilise this position, while the head and trunk are before the line of hip joints and lumbar lordosis becomes visible. Moreover, in order to control the sitting position, the baby holds the scapulae together and limbs bent in elbows, which makes it impossible for an arm to function in this position. Lower limbs are bent, abducted and externally rotated in hip joints,

flexed in knee joints and feet are in dorsiflexion. Similar to a prone position, also in a sitting position the baby shifts body weight following the turn of the head. At this age, the baby cannot perform a head turn to the side without losing balance [14].

In a standing position supported by the trunk, the baby shifts body weight to the feet and stands on straight legs which, compared to the third month of life, are held in a smaller abduction in hip joints. A strong influence of extensor muscles on the head and trunk control is noted, the scapulae are held close to the spine, elbow joints are extended or when the baby is held by the hands, elbow flexors are activated [4,5].

In the next 3-months of life, the baby improves the acquired motor skills. Free movements are dominant and balance reactions develop on the basis of extension reaction, which leads to more diverse, coordinated and smooth movement patterns. As a consequence, the baby is able to move independently and develops one's own body pattern, the feeling of self-agency and autonomy.

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