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ORIGINAL ARTICLE

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Assessment of motor development in children with postural asymmetry and the application of neurodevelopmental-based improvement methods

ABSTRACT

Background: Postural asymmetry (PA) may occur in infancy and is a diagnosis with a wide range of signs. **Material and methods:** The motor development of fifty PA children aged 0–18 months was investigated based on the use of the Alberta Infant Motor Scale (AIMS). Additional assessment was made to determine the head shape and sternocleidomastoid muscle (SCM) tone. The children underwent physiotherapy using neurodevelopmental-based improvement methods.

Conlusions: This study aimed to examine the relationship between PA and motor development in children and between the effects of therapy and the time of initiation and duration of rehabilitation. Postural asymmetry affects the course of a child's motor development. Therefore, early detection of developmental delays in a child is important, especially in terms of enabling early intervention and undertaking therapeutic measures.

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KEY WORDS: postural asymmetry; torticollis; neurodevelopmental therapy; sternocleidomastoid muscle

INTRODUCTION

Asymmetry in infancy is a clinical condition with a diagnosis of a broad spectrum of signs marked by great variability in terms of appearance, location, degree of severity and multifactorial aetiology [1]. Asymmetry may occur in the antenatal or postnatal period [2].

According to Nuysink et al. [3], idiopathic asymmetry occurs most commonly. Environmental factors play the largest role for idiopathic asymmetry. Asymmetry is less commonly reported to be symptomatic. Symptomatic asymmetry is caused by abnormalities triggering structural or functional asymmetry, where the causative factor is a disorder, disease, or dysfunction. Most children with positional preferences or asymmetry within the first six months of life are diagnosed with idiopathic asymmetry [1]. However, the initial appearance of positional preferences may be a symptom of a serious problem initiated much earlier. Therefore, a crucial aspect of the initial diagnosis to determine prognosis and treatment strategy is to distinguish symptomatic asymmetry from idiopathic asymmetry when examining infants with positional preference [3]. This allows prompt treatment initiation and selection of an appropriate therapeutic approach. The implementation of a comprehensive care plan enables the correction of asymmetry, or at the very least, its stabilization.

Positional preferences, also known as positional torticollis, is defined as a condition

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in which an infant placed in a supine position tends to keep their head turned to one side for most of the time, with no active movement to the other side within a range of 180°. Passive rotation to the non-preferred side may be possible, however, the range of motion is usually limited [4]. A disorder that is often associated with positional preference is positional plagiocephaly, also known as flat head syndrome [5]. Positional plagiocephaly and positional preferences are considered the most common postural, localised asymmetries that pose a major therapeutic challenge [6].

AIM OF THE STUDY

The effect of postural asymmetry (PA) on a child's motor development, as well as demonstrating the relationship between therapy outcomes and the time of therapy initiation.

MATERIAL AND METHODS

The study group consisted of 50 infants of both sexes with PA, including 27 girls and 23 boys aged 1–18 months, whose parents came to the rehabilitation centre for motor development consultations and nursing instruction. The infants were referred for therapy due to delayed motor development and muscular torticollis. They also exhibited plagiocephaly (in 12 cases). History taking among the examined children showed that 46 were born full-term, while 4 were premature. Assessment of the birth process revealed that 21 children were born by Caesarean section, 29 by spontaneous labuor, including 4 by vacuum-assisted vaginal delivery. The duration of pregnancy ranged from 34 to 41 weeks, with an average of 38.7 weeks. Birth weight ranged from 2440 g to 4470 g, with an average of 3543.5 g. The time of presentation with the infant for consultation varied from 1 month of age to 6 months of age, with an average of 2.9 months of age. The infants were assessed by a physiotherapist.

The study design included an assessment of motor development using the Abnormal Involuntary Movement Scale (AIMS) from 0 to 18 months of age. The assessment was classified as follows:

— below 5th percentile: suspicious motor development, therapy required;
— above 5 and below 25 percentiles: below-average motor development, therapy recommended;
— below 50 percentiles: above-average motor development, indications for discontinuing therapy, and assessment of head shape and sternocleidomastoid muscle (SCM) tone.

Physiotherapy included the entire group of 50 infants. The therapy session lasted 45 minutes, took place at the centre every other week and was continued by parents at home on the other days. During the first meeting, in addition to the assessment using the AIMS, proper prevention was discussed with the parents, which included instruction on the importance of care (carrying, lifting, laying down, feeding, changing diapers), adaptation of the child's environment (setting up the crib, selection of positions in the seat and car seat, how to arrange toys), play (time spent on the tummy) and exercise management (stimulating the development of symmetrical patterns).

The therapy was based on adapting corrective and compensatory exercises to each child's individual developmental process by tailoring comprehensive interventions. Its goal was to compensate motor deficit and stimulate proper psychomotor development. Rehabilitation procedures were conducted following the principles of neurodevelopmental methods to restore functional symmetry using inhibition and facilitation techniques and manipulation of key points according to the principles of the NDT-Bobath (Neurodevelopmental Therapy) and PNF (Proprioceptive Neuromuscular Facilitation) methods. Exercises were conducted based on sensory stimulation (eye-gaze response or sound response were used). In children with muscular torticollis, the following techniques were applied: SCM massage, neck muscle relaxation massage, neck muscle stretching exercises, and neck muscle strengthening exercises. Parents were also involved in the infant's rehabilitation process and performed the recommended exercises at home with their child to enhance the effects. The aim of the therapy was to normalise the muscular tone accompanying the infants, provide normal movement patterns to enable them to feel their bodies in symmetry and controlled asymmetry (in the case of children with congenital muscular torticollis) by reducing bad movement habits. An additional goal of the therapy in children with torticollis was to relax the tense side of the neck and achieve the ability to keep the head in a symmetrical position.

RESULTS

The obtained results were analysed using Microsoft Excel 2016 and are presented as follows:

Characteristics of the study group according to the observed asymmetry is shown on Figure 1.

After the first visit, during which an assessment of motor achievements was conducted for infants with PA, also known as positional torticollis, they were divided into subgroups. The study group consisted of 50 children, the most numerous of which was the group of children with PA, amounting to more than half cases — 26. Those were children who, after the assessment, showed asymmetric and delayed motor development, and whose head position remained in rotation to one side for about three quarters of the observation period, where passive head rotation was possible but range of motion was limited. Another large group comprised children with positional torticollis and associated plagiocephaly. This group consisted of 10 infants and, in addition to the asymmetrical pattern, this group exhibited flattening of the occiput on one side depending on the presence of the asymmetrical side. There were 7 infants in the PA group with a significant perinatal history taken from parents. Factors mentioned by the parents and contributing to significant perinatal history included forceps delivery, clavicle fracture, hearing loss, and perinatal complications. Three individuals from the entire study group were children with torticollis and associated plagiocephaly. On the other hand, the smallest groups of 2 infants each represented children with congenital torticollis and PA infants with associated plagiocephaly. Additionally, the chart below shows the characteristics of PA infants by sex and its numerical distribution.

INFANT AGE AT BASELINE AND END OF THERAPY

Between 0 and 3 months of age, 40 infants participated in their first assessment of motor skills. In contrast, 10 infants had their first assessment between 4 and 6 months of age. More than half, 26 infants, who started therapy before the age of 3 months achieved the norm at 13 months of age (Fig. 2).

PREVALENCE OF SIDE PREFERENCES FOR THE ENTIRE STUDY GROUP

In the study group, right-sided PA was more common and was observed in 35 infants. Left-sided PA was observed in 15 infants. When divided by sex, right-sided PA occurred in 18 girls and 17 boys. There were 9 girls with left-sided PA and 6 boys (Fig. 3).

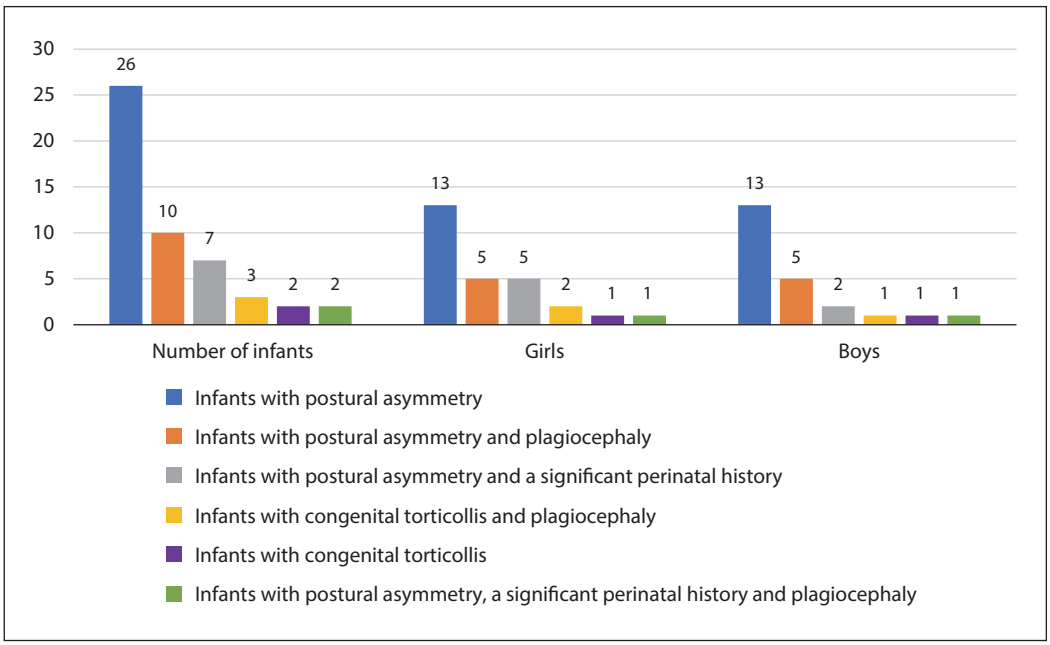

Figure 1. Characteristics of the study group according to the observed asymmetry

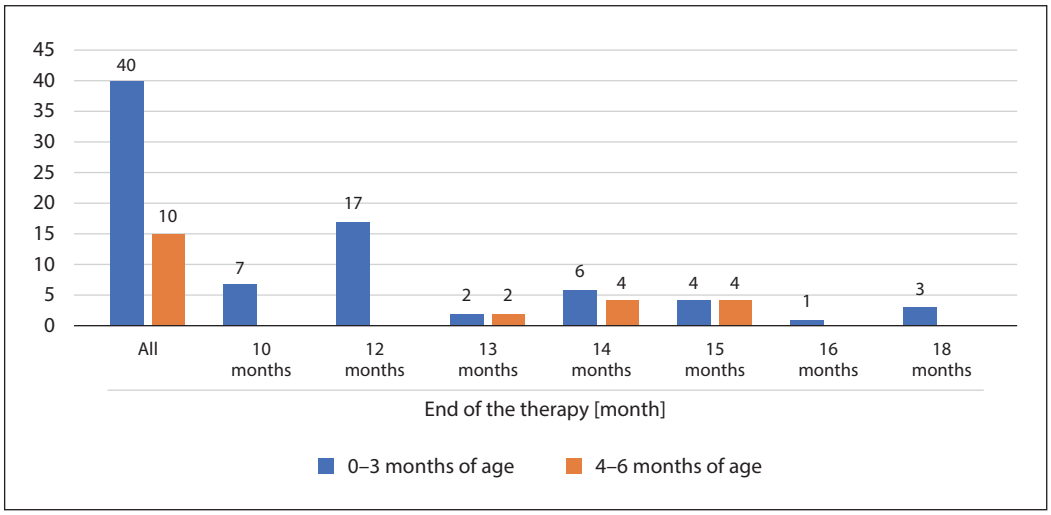

Figure 2. Infant age at baseline and end of therapy

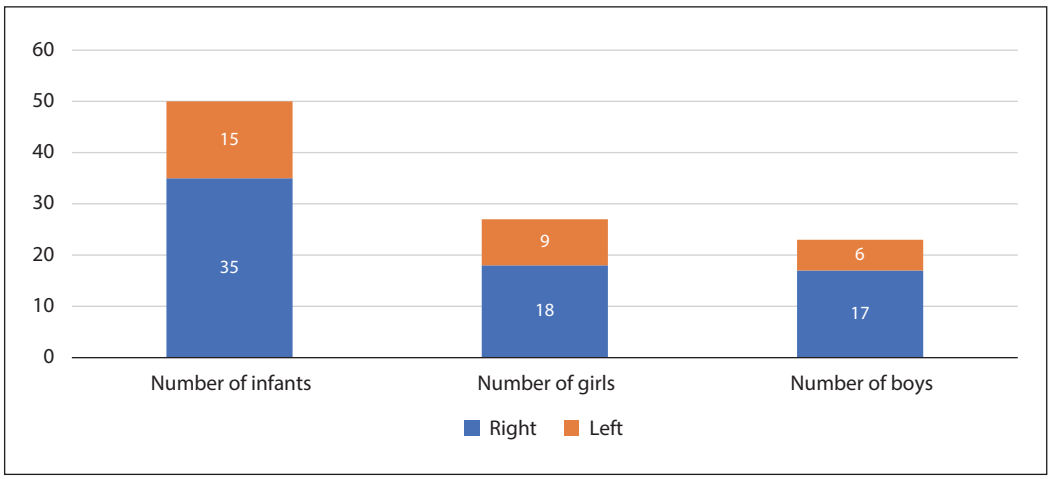

Figure 3. Prevalence of side preferences for the entire study group

PREVALENCE OF SIDE PREFERENCES FOR POSTURAL ASYMMETRY CHILDREN WITH ASSOCIATED PLAGIOCEPHALY

In the group of 50 children, there were 15 infants with apparent plagiocephaly. Right-sided PA with associated plagiocephaly was more common. In the case of boys, there were 6 cases (Fig. 4).

THE TIME OF THERAPY INITIATION VERSUS MONTH OF THERAPY COMPLETION AND THE TIME REQUIRED TO ACHIEVE NORMAL MOTOR DEVELOPMENT ON THE AIMS

During this data analysis, it should be taken into account that the results encompass the entire study group without a breakdown by associated medical conditions.

In the presented four charts (Fig. 5), it is possible to observe the relationship between the infant's month of age in which the therapy was initiated and the number of percentiles obtained on the AIMS during subsequent assessments.

Starting with the analysis of the first assessment, it can be seen that 12 infants scored below the 5th percentile on the AIMS. This is a group with a recommendation for necessary therapy. This group scored below the percentile scale as defined by the AIMS. In the range from > 5 to > 25 percentiles, there were 38 infants with a recommendation for therapy. In contrast, in the second assessment, it is already seen that in the range < 5 to > 10 percentiles, the number of infants has decreased significantly and their level of motor development reached a higher percentile. The third assessment shows that 23 infants scored > 50 percentiles, which, given the previous assumptions, allowed them

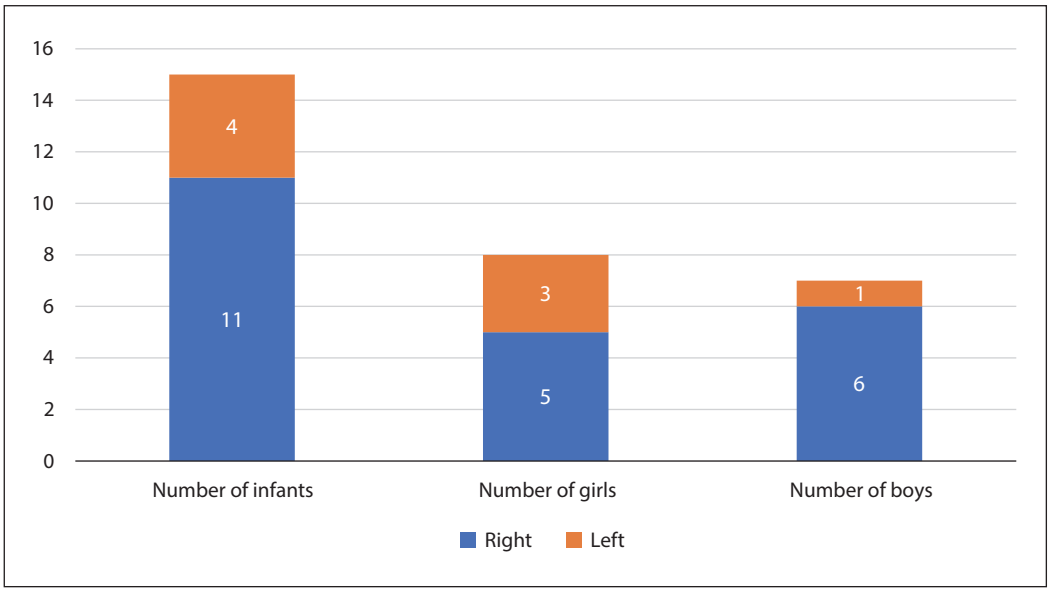

Figure 4. Prevalence of side preferences for postural asymmetry children with associated plagiocephaly

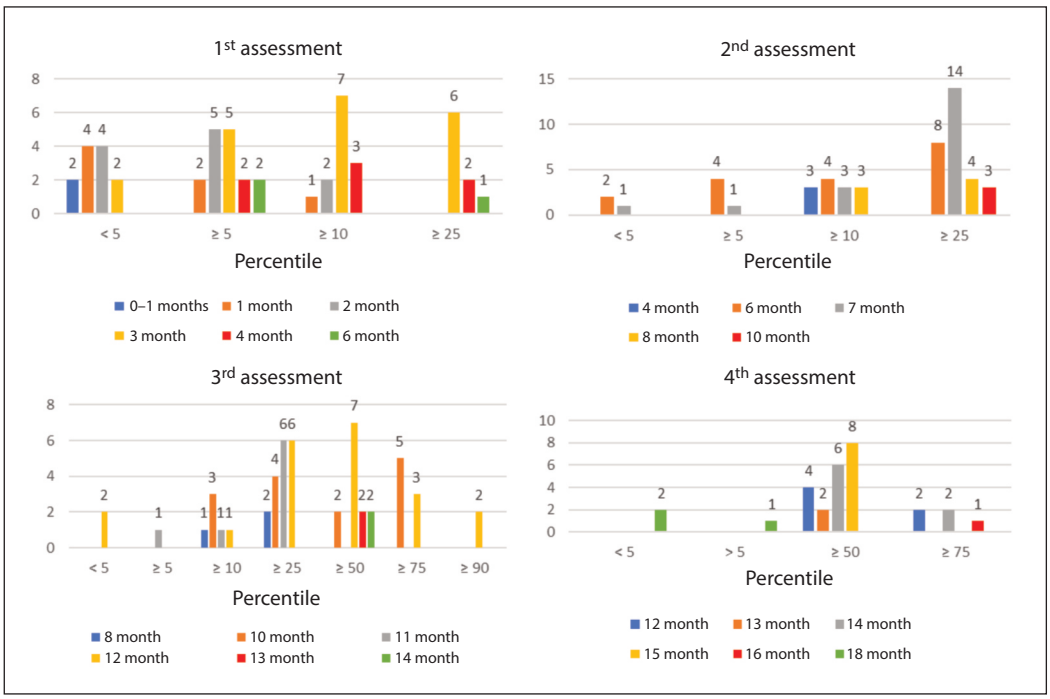

Figure 5. The time of therapy initiation versus month of therapy completion and the time required to achieve normal motor development on the Abnormal Involuntary Movement Scale (AIMS)

to complete their therapy with motor development at an appropriate level.

In the charts below, the month of the assessment has also been assigned to each percentile achieved, illustrating when and at what level the therapy was initiated and how many infants achieved each percentile in a specific month of the assessment. In the third assessment, it can be seen that a group of 19 infants achieved a norm > 50 percentiles at 10 and 12 months of age, thus completing therapy.

The time of therapy completion depended on the results achieved by the child, which were reflected in motor development norms on the AIMS. Infants who scored ≥ 50 percentiles were discharged from therapy and further observation of normal development rested with the parents.

THE TIME OF THERAPY INITIATION VERSUS THE TIME OF THERAPY COMPLETION AND THE TIME REQUIRED TO ACHIEVE THERAPEUTIC EFFECTS IN POSTURAL ASYMMETRY CHILDREN

Eighteen PA infants underwent their first assessment between 0 and 3 months of age. Seven children from this group exhibited compensation of their motor deficit at 10 months of age. In contrast, eleven children achieved the norm at 12 months of age. As a result of appropriate therapy, both of these groups reached the 90th percentile on the AIMS at the end of therapy (Fig. 6).

An eight-member group of infants who started therapy after the age of 3 months began to achieve normal motor development from 13 to 15 months of age. In terms of the number of children in this group, the most significant correction of the AIMS norm occurred in children at 14 months of age.

THE TIME OF THERAPY INITIATION VERSUS THE TIME OF THERAPY COMPLETION AND THE TIME REQUIRED TO ACHIEVE THERAPEUTIC EFFECTS IN INFANTS WITH CONGENITAL TORTICOLLIS

Five infants in the entire study group were children with congenital muscular torticollis. They exhibited a forced head position, limited passive mobility, and a shortened SCM. Two infants had muscular torticollis and three infants had muscular torticollis and associated flattening of the occiput (Fig. 7).

No plagiocephaly findings were diagnosed in infants who presented for consultation in the first month of life, and this group achieved motor improvement at 12 months of age, scoring in the 90th percentile as defined by the AIMS.

On the other hand, infants whose parents attended the assessment at three and four months of age were observed to have a flattening of the occiput, and their treatment ended at 14 and 15 months of age, after the child had reached the 90th percentile as defined by the AIMS.

THE TIME OF THERAPY INITIATION VERSUS THE TIME OF THERAPY COMPLETION AND THE TIME REQUIRED TO ACHIEVE THERAPEUTIC EFFECTS IN INFANTS WITH PLAGIOCEPHALY

The group was divided into PA children with associated plagiocephaly, PA children with associated plagiocephaly and torticollis, and PA children with associated plagiocephaly who had a significant perinatal history (Fig. 8).

Fifteen infants made up the entire plagiocephaly group. Among these children, those who started therapy in the first two months of their lives achieved the best results, reaching the highest percentile on the AIMS at 12 months of age. In contrast, infants with additional medical history of torticollis or significant perinatal history began to achieve developmental norms from 14 months of age.

The progression of motor development on the AIMS growth charts is presented on Figures 9–17.

DISCUSSION

CHARACTERISTICS OF THE STUDY GROUP ACCORDING TO THE OBSERVED ASYMMETRY

A major challenge for therapists today is positional preference and positional plagiocephaly, which are the most common postural asymmetries in infants. After the introduction of the "back to sleep" campaign to reduce the risk of sudden infant death syndrome, infant PA asymmetry and plagiocephaly have become more common [7].

In the obtained research results, infants with PA were divided into the following groups: infants with PA (positional torticollis) and plagiocephaly or without plagiocephaly, PA with a significant perinatal history, and asymmetry with congenital muscular torticollis and plagiocephaly or without plagiocephaly.

Infants with positional torticollis and without associated lesions made up the majority of the study group (26/50). Another large group consisted of infants with PA and plagiocephaly (10/50).

According to literature, positional plagiocephaly is age-dependent and strongly associated with positional preference. Van Vlimmeren et al. reported its presence in 16–22.1% of cases in 6–7-week-old infants, 19.7% at 4 months of age [8].

Majawi et al. show that positional plagiocephaly is four times more common in children who have a strong preference for one side compared to children without a side preference [2].

A Dutch study revealed a prevalence of positional preferences at 7 weeks of age in 17.9% of healthy newborns (n = 380), and positional plagiocephaly in 22.1% [8]. On the other hand, in a population-based study, positional preference was the most common in children up to 16 weeks of age — 8.2% [4].

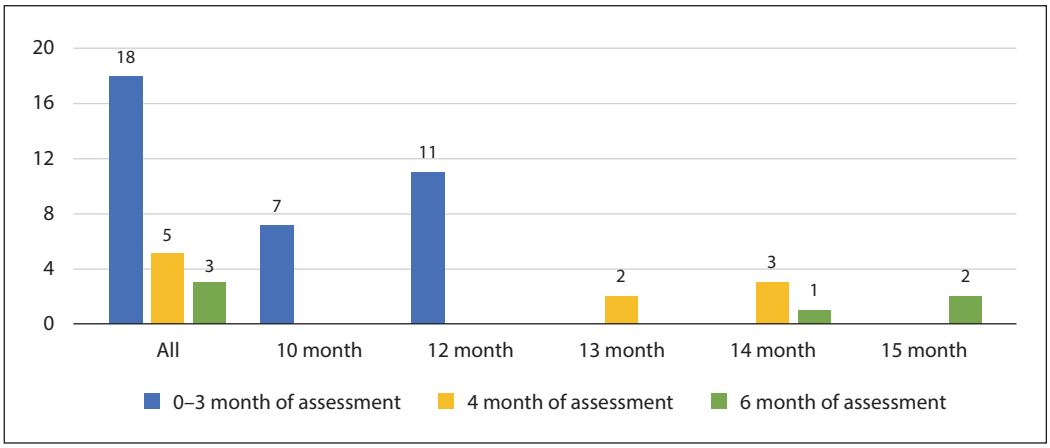

Figure 6. The time of therapy initiation versus the time of therapy completion and the time required to achieve therapeutic effects in postural asymmetry children

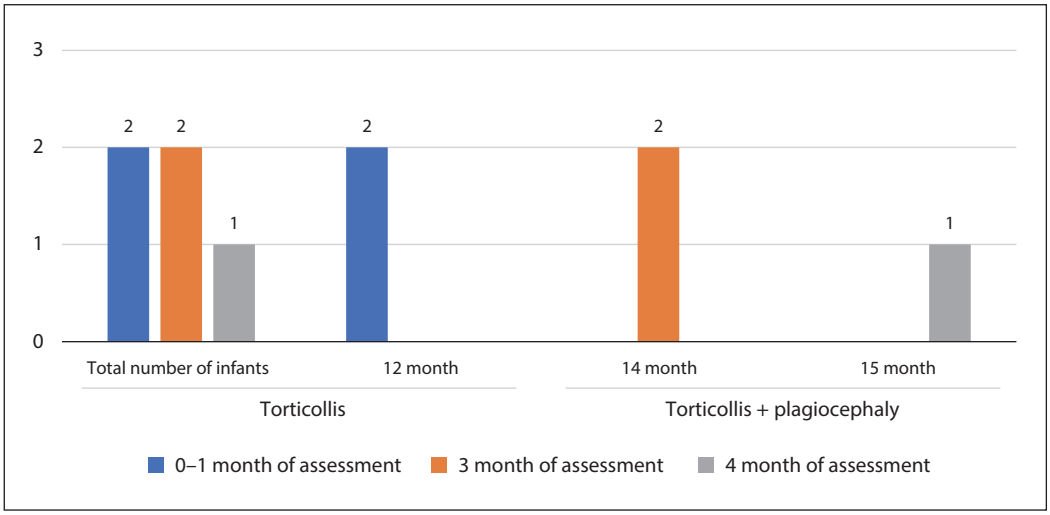

Figure 7. The time of therapy initiation versus the time of therapy completion and the time required to achieve therapeutic effects in infants with congenital torticollis

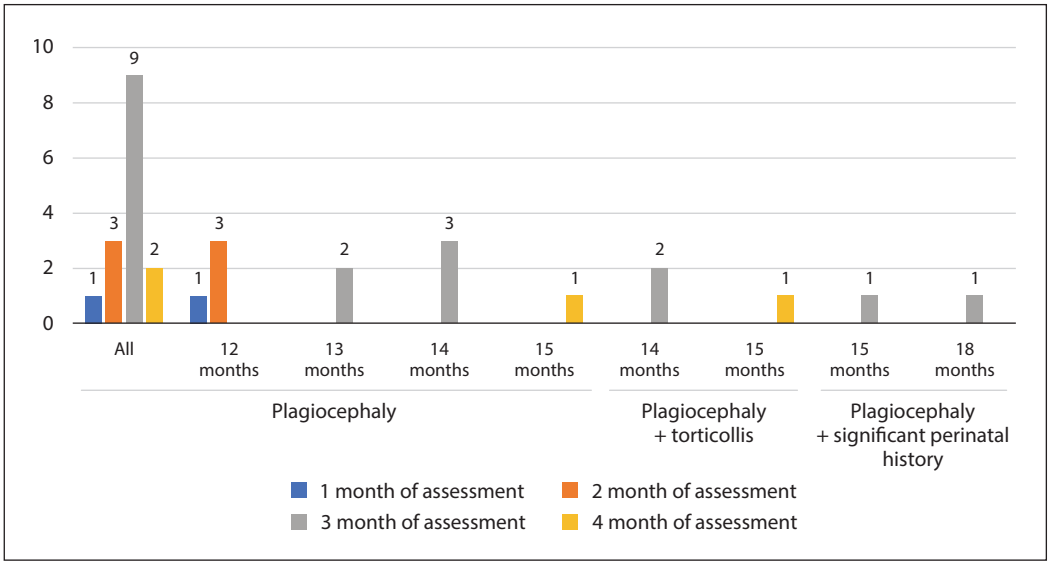

Figure 8. The time of therapy initiation versus the time of therapy completion and the time required to achieve therapeutic effects in infants with plagiocephaly

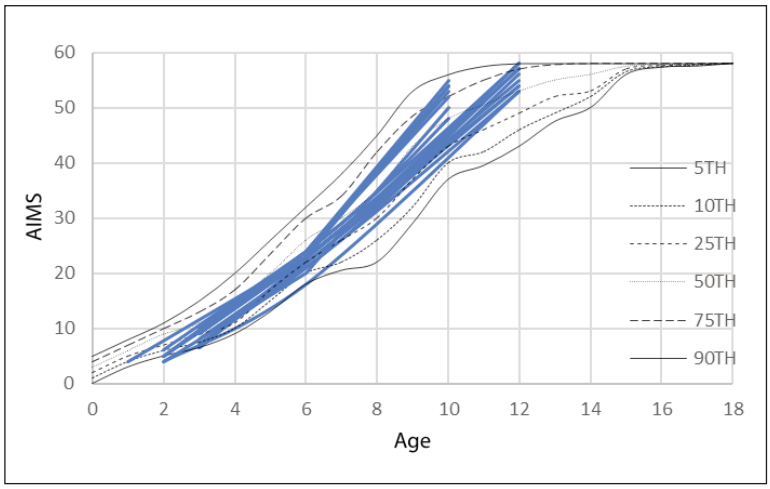

Figure 9. The presentation of the progression of motor development on the Abnormal Involuntary Movement Scale (AIMS) growth charts. Infants with postural asymmetry — 1st assessment before 3 months of age

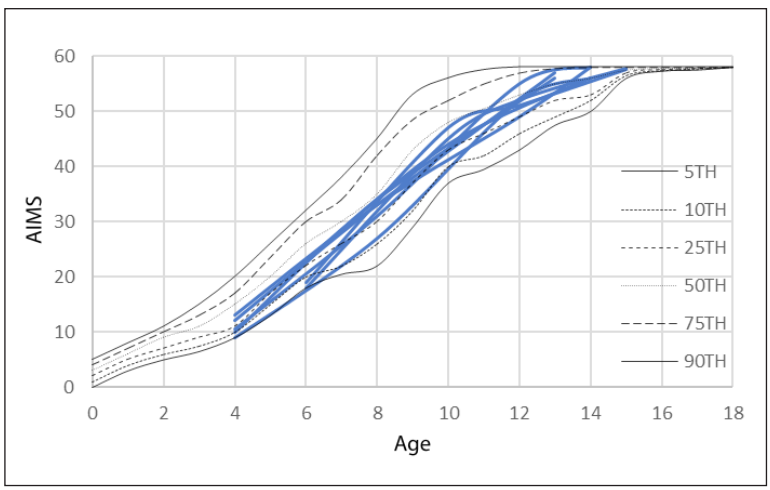

Figure 10. The presentation of the progression of motor development on the Abnormal Involuntary Movement Scale (AIMS) growth charts Infants with postural asymmetry — 1st assessment of children at 4–6 months of age

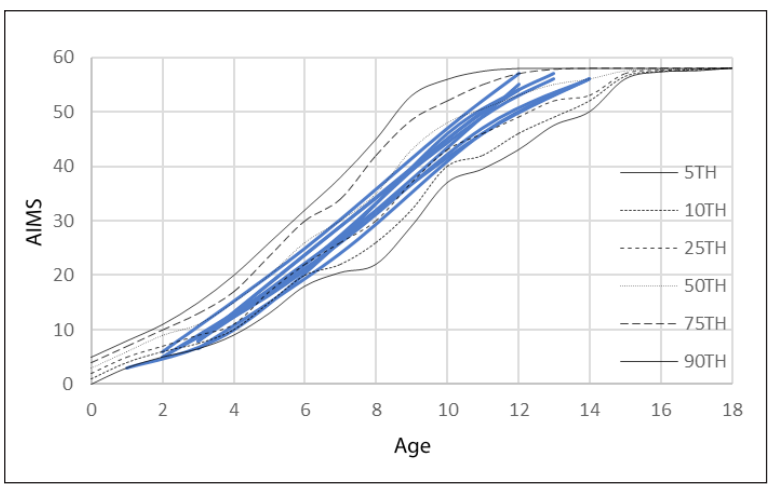

Figure 11. The presentation of the progression of motor development on the Abnormal Involuntary Movement Scale (AIMS). Infants with postural asymmetry and associated plagiocephaly — 1st assessment before 3 months of age

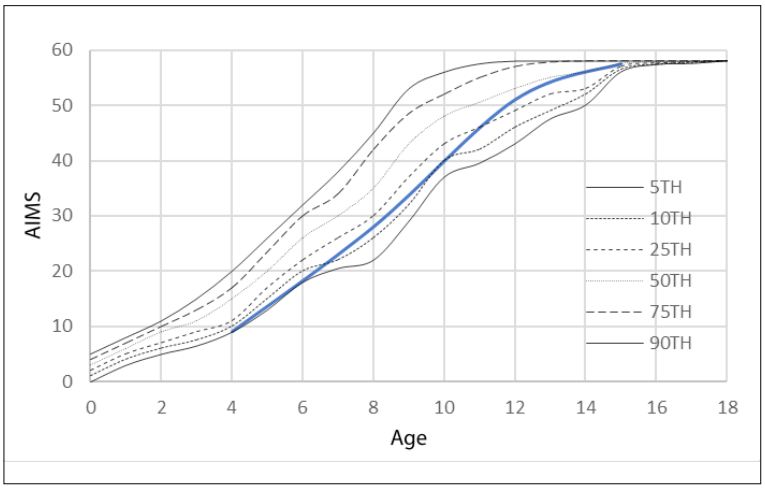

Figure 12. The presentation of the progression of motor development on the Abnormal Involuntary Movement Scale (AIMS). Infants with postural asymmetry and associated plagiocephaly — 1st assessment at 4–6 months of age

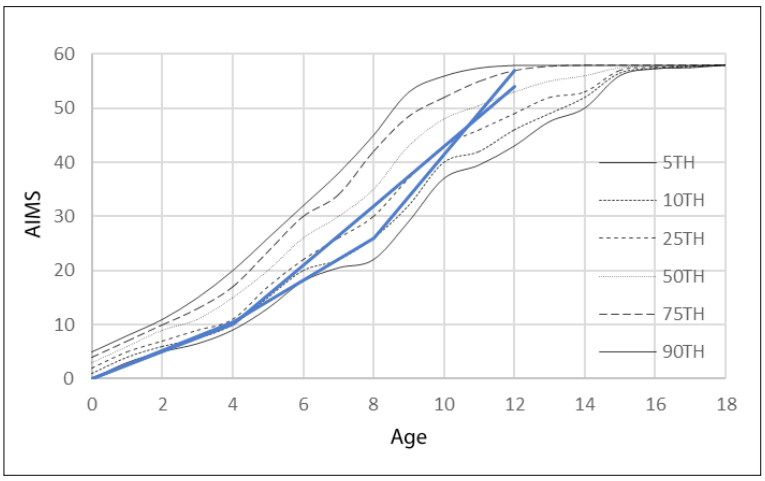

Figure 13. The presentation of the progression of motor development on the Abnormal Involuntary Movement Scale (AIMS). Infants with congenital muscular torticollis — 1st assessment before 3 months of age

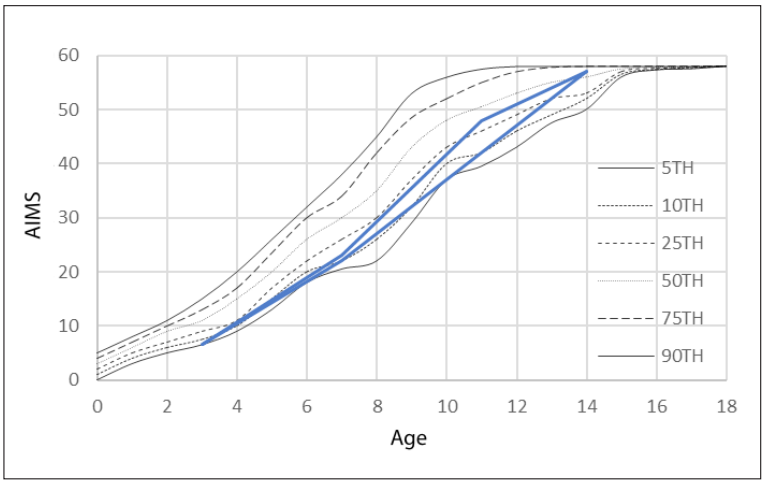

Figure 14. The presentation of the progression of motor development on the Abnormal Involuntary Movement Scale (AIMS). Infants with congenital muscular torticollis and plagiocephaly — 1st assessment before 3 months of age

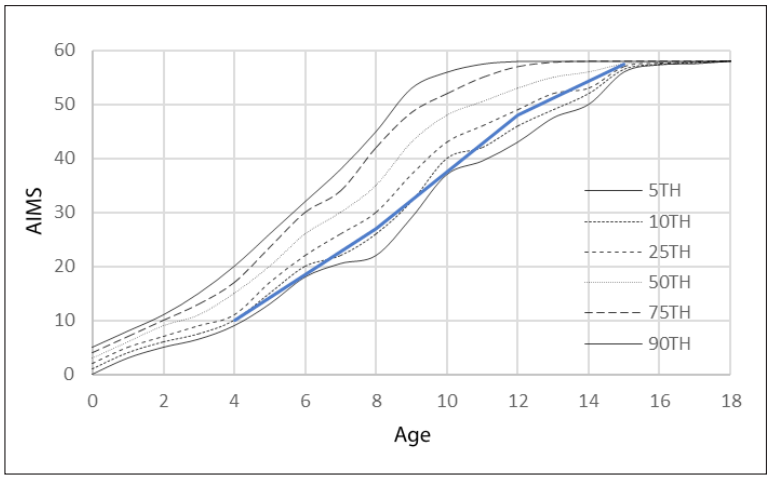

Figure 15. The presentation of the progression of motor development on the Abnormal Involuntary Movement Scale (AIMS). Infants with congenital muscular torticollis and plagiocephaly — 1st assessment at 4–6 months of age

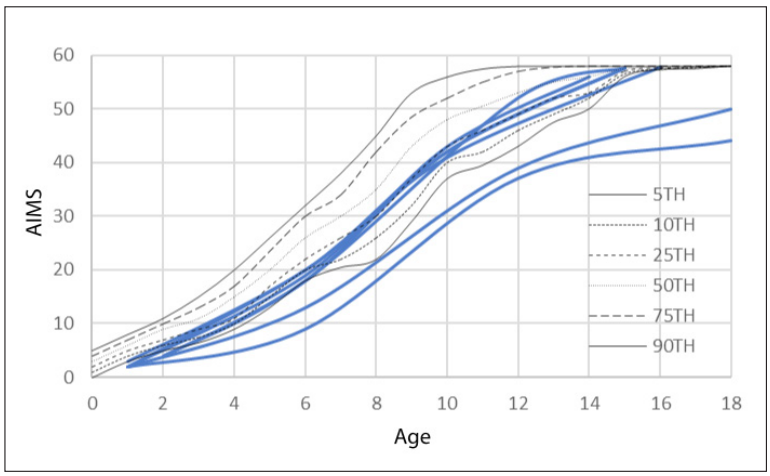

Figure 16. The presentation of the progression of motor development on the Abnormal Involuntary Movement Scale (AIMS). Infants with a significant perinatal history — 1st assessment before 3 months of age

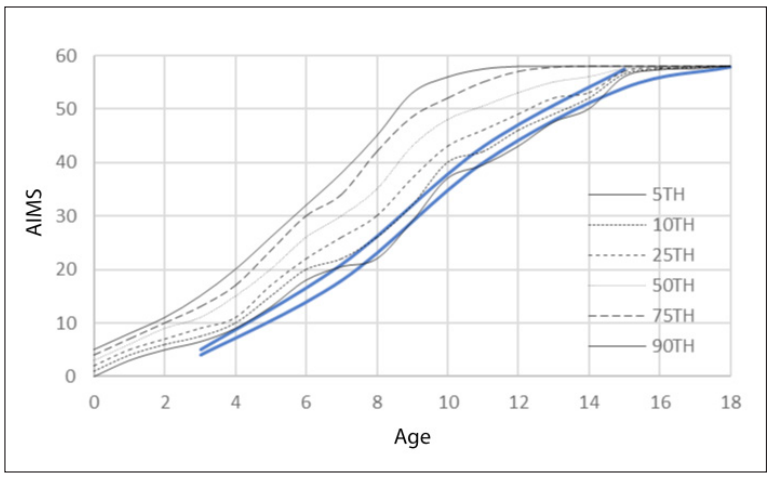

Figure 17. The presentation of the progression of motor development on the Abnormal Involuntary Movement Scale (AIMS). Infants with a significant perinatal history and plagiocephaly — 1st assessment before 3 months of age

In the study group, there was a boy with a broken clavicle among infants with PA and a significant perinatal history. According to literature, such injuries occur during 1–3% of births [2]. This injury may contribute to positional preferences and lead to asymmetry [9].

The incidence of congenital muscular torticollis is estimated to be more common in boys than girls. Congenital muscular torticollis is usually diagnosed at birth or shortly after birth [10]. According to literature, it is emphasised that congenital torticollis is often associated with plagiocephaly in 80–90% of cases [11]. In the study group of infants with congenital muscular torticollis, this conclusion was not confirmed because out of five infants in the group, three infants were girls. This is most likely due to the small size of the study group in this particular case. In contrast, three infants represented congenital torticollis with associated plagiocephaly.

PREVALENCE OF SIDE PREFERENCES

In the case of the entire study group, 70% of infants represented a right-sided pattern of asymmetry. Similarly, for infants representing positional torticollis with associated plagiocephaly, the incidence was 73% for the right side.

In Szymanska's study, the group of newborns most often presented with their heads turned to the right side. This was observed in 30 out of 50 infants, accounting for 60% [12]. In contrast, Majawi et al. reported that in cases of PA, a flattening of the occiput affected the right side in 63.8% of cases [2].

Philippi et al. draw attention to the fact that in cases of plagiocephaly, flattening occurs twice as often in boys as in girls, which may be due to the less plasticity of the head and its larger size [13]. This result was confirmed in the research. In the group of infants with asymmetry and plagiocephaly, right occipital flattening was more common among boys.

POSTURAL ASYMMETRY AND THE TIME OF THERAPY INITIATION

The age at which a diagnosis is made is crucial in deciding on the appropriate rehabilitation plan and therapy approach for a child with PA. Flow diagrams developed by the Academy of Pediatric Physical Therapy are very helpful when managing a child with PA [14].

In the case of congenital muscular torticollis, early diagnosis, proper positioning prevention, and appropriately selected physiotherapy can potentially eliminate the need for surgical treatment and lead to significant progress in therapy. In their study, Wendland and Wojciechowski published results indicating that conservative treatment starting from the third week of life can lead to complete recovery [15].

MOTOR DEVELOPMENT OF POSTURAL ASYMMETRY CHILDREN

Many authors emphasise the strong correlation between the asymmetrical positioning of an infant's head and body and their subsequent development. They also highlight the importance of initiating rehabilitation when asymmetry is observed or long-lasting [7, 10, 16]. Symmetrical body positioning significantly influences overall motor development and posture. Hence, an important factor in reducing the incidence of PA in infants is parental education on proper care, adherence to care, and the implementation of appropriate therapy.

In the conducted study, some of the infants who were assigned to the group with PA revealed clinically significant improvement as early as 10 months of age, leading to their discharge from therapy while remaining under observation. Also, it should be noted that these infants began therapy before the age of three months and, in addition to the therapy at the centre, parents followed instructional recommendations and exercises that were advised to them during therapy sessions.

When considering the group as a whole, the infants who started therapy in their early months of life achieved the desired effects on the motor development norms as defined by the AIMS much faster than their peers who started the exercises later. This may imply that early therapy initiation is more beneficial than therapy delay.

Watemberg et al. found that infants with congenital muscular torticollis are accompanied by functional asymmetry, which affects every fourth child they examined. This functional asymmetry can lead to a delay in motor development.

The issue of motor delay accompanying these conditions has also been addressed by other authors. In their study, using the AIMS, they identified statistically significant differences in terms of motor delay in children with developmental disorders compared to a control group of healthy children. They re-

ported that the delay in motor development compensates from 10 months of age to 1 year of age [17, 18].

Van Vlimmeren et al. conducted a study in infants with deformational plagiocephaly and positional preference before the age of 6 months. The intervention involved standard repositioning and physiotherapy protocols. After the intervention, the proportion of infants with severe deformational plagiocephaly in the study group was significantly lower than in the usual care group. The researchers also found that positional preferences disappeared in all infants in both groups by the age of 12 months. This finding implies that without intervention, some infants with positional preference and deformational plagiocephaly may progress to a severe form of deformational plagiocephaly, even though the positional preference disappears by the age of 1 year [7].

CONCLUSIONS

Postural asymmetry affects the course of a child's motor development. Therefore, early detection of developmental delays in a child is important, especially in terms of enabling early intervention and undertaking therapeutic measures.

In the case of PA, therapy is necessary for developmental reasons. The child has the opportunity to compensate spontaneous motor deficits and normalise muscle tone. Therapy is also important for aesthetic reasons to prevent the onset of deformations or reduce them, e.g. cranial deformations.

Infants with muscular torticollis who started therapy later often had plagiocephaly, while infants with muscular torticollis who began therapy before 2 months of age did not exhibit lesions in the form of a flattening of the occiput and achieved developmental norms more quickly.

Infants with muscular torticollis who started rehabilitation early in life reached motor development norms sooner than their peers with torticollis who received therapeutic intervention later.

Children more commonly presented with right-sided PA.

The presented research demonstrates the beneficial effect of proper care and early physiotherapy on improving the motor development of PA children. The later rehabilitation was initiated, the longer it took to see therapeutic effects, and these effects were achieved by infants at later months of their life. The resulting delays in motor development may not only have been influenced in the study group by the time of therapy initiation, but also by the accompanying more or less significant medical histories that the children additionally represented.

CONFLICT OF INTEREST

Authirs declare no conflict of interest.

FUNDING

None.

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