Development of a Symmetry Score for Infantile Postural and Movement Asymmetries: Preliminary Results of a Pilot Study

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ABSTRACT

Objective: The purpose of this study was to develop and verify a quantifiable symmetry score for infantile postural and movement asymmetries.

Methods: Three studies were conducted. For reliability, 6 test items examining postural and movement asymmetries, which came under consideration, were investigated in 24 infants with postural abnormality (range: 14-24 weeks). The inter-rater reliability was chosen as the primary endpoint. Furthermore, intrarater reliability and test-retest reliability were determined. Analysis and weighting of the items were performed by calculating the intraclass correlation coefficient. The validity was reviewed by expert opinion and by using a study with 26 infants (range: 12-28 weeks) of a cross-section population. The pilot study involved 38 infants, aged 14 to 24 weeks, who were examined using video. Their autonomic symptoms were recorded, and subsequently, they were treated once by means of manual medicine. The parents were instructed to a daily home program that focused on “tummy time.”

Results: The reliability tests led to a 4-item symmetry score with a point value between 4 points (very symmetrical) and 17 points (very asymmetrical). The chosen items achieved an intraclass correlation coefficient >0.8 and Cohen's $\kappa >0.6$, respectively. The experts' opinions matched mainly to a majority agreement ($>50\%$). Furthermore, a comparison between the outcome of clinical testing and the symmetry score applied to 26 children without diagnosed abnormalities displayed an agreement of 84.6%. The pilot study showed a good reduction of the postural and movement abnormalities because 63% of the manual treated children were assessed as being symmetric afterward.

Conclusion: The reliable and valid 4-item symmetry score served for the diagnosis, evaluation, and follow-up of infants aged 3 to 6 months with infantile postural and movement asymmetries. The results of a pilot study showed the positive effect of a single manual medical treatment session along with a home program focusing on “tummy time.” (J Chiropr Med 2018;17:206-216)

Key Indexing Terms: *Infant; Child Development*

INTRODUCTION

Although variable positional, postural, and movement asymmetries are considered to be indications of a developing physiological postural motor system, constant early childhood asymmetries of head or body posture, spontaneous movement, or muscle tone are mostly expressions of abnormal sensory-motor coordination and require diagnosis and, if necessary, treatment.¹⁻⁸ In pediatric practice in Germany, the term “kinematic imbalance due to suboccipital strain (KISS)” is widely accepted.^{1,7,9} The concept ascribes a decisive importance to segmental dysfunctions in the craniocervical junction in the pathogenetic occurrence of development of asymmetry. There are references to the neurophysiological foundations

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Table 1. Overview of the Demographic Data

	Reliability Study	Validity Study	Pilot Study
Number of infants included	24	26	38
Time frame	February-June, 2013	November, 2014-February, 2015	March-July, 2015
Age, in wk	14-24 (mean: 17)	12-28 (mean: 20)	14-24 (mean: 17)
Sex (female/male)	9/15	13/13	12/26

for this proprioceptive musculoskeletal coordination disorder.^{7,10,11} Postural and movement abnormalities of infants with systemic underlying diseases, such as neurologic disorders, genetic anomalies, dysplasias, or metabolic disorders, have to be distinguished from these.

Based on clinical observations, between 8% and 30% of all infants may develop constant postural and movement asymmetries during the first months of life.^{2,3} The causes of such early childhood asymmetrical development are the subject of controversial discussion. The terminology and diagnoses are also diverse and are needed for the identical constellation of symptoms for infants without the presence of systemic underlying diseases. They range from “Siebener’s syndrome (syndrome of contractures)”¹² to “infantile scoliosis”⁸ and “cervical diencephalic static syndrome of infants,”¹³ all the way to “idiopathic infantile asymmetry”¹⁴ and finally to “infantile postural asymmetry.”⁶

Because, from a functional orthopedic viewpoint, segmental disorders in key regions of the locomotor system stand in the forefront as catalysts for constant postural and movement asymmetries, there are various manual medicine and osteopathic concepts for diagnosis and treatment.

Current treatment options for infantile postural asymmetry and KISS, respectively, are physiotherapeutic methods and manual medical or osteopathic treatments. There is indeed positive clinical experience of these treatment approaches (latest level of evidence IV for manual medicine)¹⁵; however, there are no evidence-based studies on levels I or II. Thus, the scientific evaluation of a manual medical treatment approach is of primary importance.

In a placebo-controlled small study, positive effects of osteopathic treatment of infants, aged between 6 and 12 weeks, were observed.⁶ Because the score used by Philippi et al⁶ could not be applied to the target group, the authors developed a sensory-motor symmetry score and tested it for reliability and validity. Therefore, the purpose of this study was to design an objective sensory-motor development score for infants aged 3 to 6 months with infantile postural and movement asymmetry or KISS. This study also assessed if the symmetry score was feasible for investigating manual medical treatment for affected infants in a pilot study.

Fig 1. Modified frontal righting reflex reaction.

Fig 2. Active head rotation in supine position.

Fig 3. Head up-lifting in prone position.

METHODS

The 2 studies to investigate the quality criteria and the pilot study were all approved by the Ethics Committee of the University Hospital of Jena. At the end, 3 different studies were accomplished (Table 1). Respectively, each rater and examining or treating physician is a medical doctor (>15 years) and specialist for manual medicine in pediatrics (>5 years). Only 1 participant, acting as rater in the reliability study, was a medical student in the fifth year of qualification (>1 year of experience in the pediatric field).

Symmetry Score: Selection of the Items and Conceptual Design of the Symmetry Score

The basis for item selection and subsequent clinical trial is the demonstration of postural and movement asymmetry

in infants, aged 3 to 6 months, in the context of an objective system. An additional criterion is the ability to upright the head from the prone position. In a second step, the identified test items were tested regarding reliability and consolidated into a symmetry score. In addition, these were video documented in 3 different dimensions and, subsequently, ascertained and evaluated by 6 raters, either qualitatively, semiquantitatively, or quantitatively. All raters underwent training in handling the video sequences and the measuring principle. In a third step, the score, and hence the resulting scale, were tested for validity. Building upon the investigational results from Philippi et al,¹⁴ and the long-lasting experience of the medical task force, the following clinical test items were selected: (1) modified frontal righting reflex (FRR; Fig 1), (2) active head rotation in supine position (AHROT; Fig 2), (3) head up-lifting in prone position (Fig 3), (4) muscular tonus asymmetry right and left (Fig 4), (5) passive head rotation (PHROT), and (6) reactive trunk convexity with head rotation (RTC).

Item 1: Modified Frontal Righting Reflex. The infant sat on the examiner's stomach and was held steady in the pelvic area. After tipping the infant about 45° to the side, a compensating vertical rising of the head was expected. The extent of this FRR was measured in a standard way between the body axis and head axis. The trunk axis corresponded to the median line of the trunk; the head axis was defined by the median line of the face. The intersection point of both axes lies, as a rule, above the mouth. The provocation examination was held for a few seconds each time and filmed a total of 3 times in lateral comparison from the front (camera 1, Fig 5). Each time, the provocation test was evaluated with maximum head lateral flexion per side in a freeze image. The basis for the quantitative test results was the side difference measured in degrees.

Fig 4. Muscular tonus asymmetry (hip rotation).

Fig 5. Camera positions.

Item 2: Active Head Rotation in Supine Position. The infant lay on their back and was aligned in a neutral posture of the trunk-head area. A maximal head rotation to the left or right was provoked by means of an optical or acoustic stimulus and filmed from the front in a total of 3 tests per side (camera 1, Fig 5). The provocation examination was evaluated with the maximal head turning per side in the freeze frame. The angle was measured between the shoulder axis (in the ideal case, identical to the level of the examination table) and the connecting line between the localization of the posterior fontanelle and the middle of the forehead or tip of the nose. The basis for the quantitative test results was the side difference measured in degrees.

Item 3: Head Uplifting in Prone Position. The infant, lying prone, was animated by means of an acoustic or optical stimulus to lift its head the maximum amount vertically. The angle between the horizontal and the mouth or bridge of the nose line was measured (camera 2, Fig 5). The test was done 3 times, and the best test result was used. The item was thus calculated from the difference between 110° and the maximum reproducible uplifted head.

Item 4: Muscular Tonus Asymmetry, Right or Left. The infant lay on their back and was held with legs flexed in the hip and knee joints. Through testing the passive external rotation in the hip joint, the end of the range muscular tension of the region was qualitatively determined in simultaneous lateral comparison (camera 3, Fig 5). Difference: yes or no response.

Item 5: Passive Head Rotation. The infant lay on their back. A single PHROT, with inclination of the cervical vertebrae, was induced to the left, and afterwards, to the right (camera 3, Fig 5). Any recognizable side difference of the head rotation was rated qualitatively by a yes or no response.

Item 6: Reactive Trunk Convexity With Head Rotation The reactive trunk adjustment, with intended turning of the head in supine position, was examined (camera 3, Fig 5). The test was repeated 3 times each for both sides (trunk convexity

Table 2. Inter-rater Reliability

Item Computation: ICC	Reliability
Difference active head rotation	0.972
Difference frontal righting reflex	0.867
Head uplifting in prone position	0.821
Reactive trunk convexity with head rotation, right	0.554
Reactive trunk convexity with head rotation, left	0.541
Item Computation: κ	
Passive head rotation	0.242

ICC, intraclass correlation coefficient.

with right head rotation, RTC to the right; trunk convexity with left head rotation, RTC to the left). Each time, the test was evaluated with the most explicit trunk convexity based on semiquantitative criteria: none, limited, and moderate definite.

Symmetry Score: Video Documentation

A 3-dimensional recording of the movement sequences was used for the video documentation of the test items (Fig 5). The 3 video recordings were done simultaneously, according to the test procedure. The vertical camera 3 was set at a distance of 1 meter from the examination table, and the sideways and cranial cameras (2 and 1) were each 1.5 meters from the object of the examination. The standardized focus (film) distances were not changed until completion of the examination. The result was a format-filling resolution in high definition quality.

The parents, a video assistant, and the examiner were all present while the infant was tested. The parents remained outside the child's visual range. The video assistant continuously checked the recording settings. The child was aligned in a neutral head-trunk position corresponding to the respective test item. The prone position of the particular child was not corrected. All examinations were done while children were in a calm but active initial state or were halted if necessary. The examination room was kept at a low level of stimulation, the light intensity was adjusted to be moderate and uniform, and the examination mat was preheated.

The examination of test items 2, 3, and 6 were done with the aid of presentation of toys, sounds, moderate light sources, or if necessary, with the inclusion of 1 of the parents.

Metric evaluation of the test item was done by means of a virtual protractor. The Onde Ruler software for Macintosh¹⁶ and MB-Ruler software for PC¹⁷ were used to do this. Measuring accuracy was given by a standard check for both systems. Twenty-two freely selected angles between 5° and 180° were measured by 2 raters by means of a set square (M+R Plexiglas 32 cm), then digitalized and verified with the respective program.

Table 3. Intrarater Reliability

Item: ICC	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5	Rater 6
Difference active head rotation	0.767	0.518	0.635	0.572	0.729	0.424
Difference frontal righting reflex	0.833	0.750	0.670	0.689	0.630	0.658
Head uplifting in prone position	0.803	0.802	0.785	0.787	0.765	0.605
Reactive trunk convexity with head rotation, right	0.364	0.308	0.225	0.148	0.405	0.202
Reactive trunk convexity with head rotation, left	0.308	0.504	0.607	0.674	0.327	0.152
Item: κ						
Passive head rotation	0.600	0.500	0.263	c	c	1.000
Muscular tonus asymmetry (hip rotation)	0.909	0.500	0.600	0.664	0.408	0.583

C, constant (κ not calculable); ICC, intraclass correlation coefficient.

Symmetry Score: Reliability Analysis

The test items were subjected to a reliability analysis for the areas of inter-rater reliability (primary endpoint, Table 1), intrarater reliability (secondary endpoint, Table 2), and test-retest reliability (tertiary endpoint, Table 3), to subsequently develop an evaluation scale, which can be used in clinical studies.

Between February and June 2013, 30 infants were given neurologic development and functional orthopedic examinations by the lead and secondary authors. The infants were recruited in the context of the manual medicine and developmental therapy practice for children in Dortmund, Germany. Appropriately, noticeably affected children were given the diagnoses of “infantile postural and movement asymmetry” or KISS by registered pediatricians. The previously conducted pediatric screening examination (SE) (first SE: after birth, second SE: after 3 to 10 days, third SE: after 3 to 4 weeks, and, if necessary, fourth SE: after 3 to 4 months, as well as the sonography results for the hips) were otherwise unremarkable.

Inclusion criteria were the presence of a constant postural and movement asymmetry, as well as an adjusted age of 14 to 24 weeks. Exclusion criteria were held to be the demonstration of the presence of systemic underlying diseases (eg, neurological disease, metabolic disorders, or dysplasia), injuries to the spinal column, hip dysplasia, chromosomal aberrations, genuine infantile scoliosis, or the presence of muscular torticollis or premature birth (<37 weeks).

The examination and video documentation of the 6 test items were done each time for the instant of time test 1 (T1) and T1+15 minutes (re-test). For 6 of the 30 infants, the test-retest examination could not be conducted completely; therefore, the children were withdrawn from the study. The basis for this was the examination standard that was selected. Thus, the items should only be tested in a calm and active condition. As a result, the test-retest reviews prolonged the overall time period of the examination

significantly. This led to either increased restlessness or tiredness of the infants.

The video sequences for 24 infants (9 female) were submitted to analysis by 6 raters, independently. All raters were experts in manual medicine for years and specifically qualified. The determination of the inter-rater reliability was based on the evaluations of the T1 films. The test-retest reliability was calculated from the examination results for the instant of time T1 and T1+15. After 4 to 6 weeks, the video sequences for point of time T1 were, again, sent to the raters and analyzed for calculation of intrarater reliability. The reliability analysis for items 1, 2, 3, and 6 was performed through calculation of the intraclass correlation coefficient (ICC)¹⁸; items 4 and 5 were tested according to Cohen's κ .¹⁹ Interpretation of the results for the statistical method of measurement was done for the ICC by Bortz and Weber,¹⁸ who determined the following scores: >0.9, high; 0.7 to 0.9, satisfactory; 0.5 to 0.69, adequate; and <0.5, not adequate. Interpretation of the results for κ by Landis and Koch¹⁹ revealed the following scores: 0.81 to 1.00, almost perfect; 0.61 to 0.80, noticeable; 0.41 to 0.60, moderate; 0.21 to 0.40, sufficient conformity; 0 to 0.20, limited conformity, and <0, bad conformity.

The purpose of the reliability study was to reach at least a power of 80% at a significance level of 5% for the primary endpoint. The power analysis, accordingly carried out with use of an ICC ≥ 0.6 and 6 raters for 24 test participants, yielded a reliable measurement result with an ICC of ≥ 0.8 .

The reliability calculation was conducted at the Institute for Medical Statistics, as well as the Research Advisory Centre of the German Association for Manual Medicine at the Institute for Physiotherapy of the University Hospital of Jena.

Symmetry Score: Validity Analysis

Validity testing for the symmetry score followed the recommendations of Holle,²⁰ by means of expert opinions, and a clinical validity study. Physician colleagues were

Table 4. Test-Retest Reliability

Item: ICC	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5	Rater 6
Difference active head rotation	0.767	0.518	0.635	0.572	0.729	0.424
Difference frontal righting reflex	0.833	0.750	0.670	0.689	0.630	0.658
Head uplifting in prone position	0.803	0.802	0.785	0.787	0.765	0.605
Reactive trunk convexity with head rotation, right	0.364	0.308	0.225	0.148	0.405	0.202
Reactive trunk convexity with head rotation, left	0.308	0.504	0.607	0.674	0.327	0.152
<hr/>						
Item: κ						
Passive head rotation	0.600	0.500	0.263	c	c	1.000
Muscular tonus asymmetry (hip rotation)	0.909	0.500	0.600	0.664	0.408	0.583

C, constant (κ not calculable); ICC, intraclass correlation coefficient.

selected as experts for the clinical functional examination of infants with infantile postural asymmetry; they possessed established clinical experience with appropriate abnormal infants. The list of experts, consisting of 61 physicians, is prepared with the support of the Physicians' Seminar for Manual Medicine, Berlin. The expert opinion is reviewed according to the recommendations of the AWMF (*Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften* [Association of the Scientific Medical Societies in Germany])²¹.

In a second step, the clinical examination results of an established physician in the diagnosis of early childhood postural and movement asymmetries was compared with the results of the final symmetry score for 26 children. The videos were analyzed by a trained medical rater who had no knowledge of the previously conducted routine examination. Based on the score's number of points (>9), a need for treatment could be determined. Both results are subsequently compared in a cross tabulation.

Twenty-six infants (13 male) from a randomly selected cross-section population were routinely examined between November 2014 and February 2015 and evaluated for their postural and movement symmetry (need for treatment yes or no). Subsequently, the testing of the score items was filmed. The examination population was composed of 10 infants from a Prague Parent-Child Program group (examiner A, rater B) and 16 children from a pediatric practice (U4 and U5 routine examinations: examiner C, rater D).

Pilot Study: Using the Symmetry Score

The aim of the study is to evaluate a single manual medical treatment for children with postural or movement asymmetries. To this end, 38 infants were recruited for the pilot study between March and July 2015 in 7 study centers. No control group was examined. Moreover, the pilot study shall be used for sample size planning and preparing for a multicenter

randomized controlled trial. Patients were assessed using the newly developed symmetry score followed by individual single treatment by means of manual medicine. Four to 6 weeks later, a second examination with the symmetry score followed to assess the development of physical asymmetry. The examining and the treating physician were 2 different people. In addition, the parents were instructed for the home program, which included exercises in different positions called "tummy time." Patient inclusion criteria were a symmetry score value of at least 10 points, a corrected age of 14 to 24 weeks, and the diagnosis of a reversible, functional segmental disorder. Exclusion criteria were systemic primary diseases, a muscular torticollis, chronic or acute infections, prematurity (<37 weeks), manual therapeutic or osteopathic treatments in the last 4 weeks, physiotherapy or vaccinations in the last 2 weeks, or poor German language skills of the parents. Scoring by the 4-item symmetry score was documented on video. The 2-sample t test was used for testing significance of difference. Furthermore, the parents were interviewed to accompanying autonomic symptoms, including spitting, sleeping, drinking or breast feeding, crying, defecation, feeling or mood, and irritability. In addition, the autonomic frequencies were counted and compared before and after the treatment to see if they got better, were the same, or were worse.

RESULTS

Testing of the measuring instruments Onde Ruler and MB-Ruler yielded a 100% consistency at a measuring accuracy of the set square of 0.5° . Hence, both software instruments are usable for the symmetry score and this study setting.

Symmetry Score: Reliability Analysis and Development

The reliability calculations are presented in Tables 2 to 4. Because of the determination of only constant values for the

Table 5. Reliability of the 4 Remaining Items of the Final Symmetry Score

Item	ICC	ICC	ICC	κ
	1 – Frontal Righting Reflex	2 – Active Head Rotation	3 – Head Uplifting in Prone Position	4 – Muscular Tonus Asymmetry
Intrarater	0.915	0.946	0.93	0.92
Inter-rater	0.867	0.972	0.820	0.6

ICC, intraclass correlation coefficient.

item PHROT for intrarater reliability (rater 5), and the test-retest reliability (raters 4 and 5), κ could not be calculated. The values remained disregarded for the overall calculation. The items RTC and PHROT did not reach any sufficient inter-rater reliability for the sample size selected. Therefore, both items were not included in the final score.

For a more practical version, the items FRR and AHROT are no longer divided into 2 sides, but from now on will be calculated as difference between the sides. This option seems to be more realistic for the side difference because it supports the comparability among the children. The reliability for the remaining items is shown in Table 5.

Symmetry Score: Development of a Numerical Scale and Validity

For items 1 to 4, which were considered reliable, a numerical scale was developed. The scaling and the evaluation standard were based on clinical considerations and the experience gained in the context of the reliability analysis. Appendix A (available online only) includes the list of items.

Subsequently, the authors tested the score with 3 quantitative items and 1 qualitative item for its validity in relation to infantile postural and movement asymmetries or KISS (Tables 6 and 7). A total of 61 independent experts were asked whether the items that were finally proposed were suitable for identification of infants with infantile postural asymmetry. Twenty-three colleagues responded. Of these, the authors were able to utilize 22 written answers (for item 4 only 21 written answers).

Thus, the expert opinion yields a consensus for item 4 and a majority agreement for items 1 to 3. A portion of the experts voted for a less restrictive setting for the treatment indications.

Table 6. Validity: Expert Opinion Agreement of the Final Symmetry Score Concerning Item Selection and Assessment

Item	Number of Experts	Percentage
Frontal righting reflex	Agreement of 15 of 22	68.2%
Active head rotation	Agreement of 12 of 22	54.5%
Head uplifting in prone position	Agreement of 12 of 22	54.5%
Muscular tonus asymmetry (hip rotation)	Agreement of 16 of 21	76.2%

Note: Agreement as per the AwMF²¹: strong consensus >95%; consensus >75%; majority agreement >50%; no consensus <50%.

Nevertheless, it would be unrewarding to open the classification because this could cause a decrease of objectivity of the score. The validation calculation with the comparison yielded a score specificity of 94.4% at a sensitivity of 62.5%.

The assessments of the need for treatment of children with postural and movement asymmetries, based on the 4-item symmetry score, concurs with the examiner's results at 84.6% (significance: $P = .004$). This confirms the validity of the 4-item symmetry score as an instrument for assessment of the need for treatment in regard to postural and movement control in infants.

Pilot Study: Results

The progression of the symmetry score shows significant improvements in all 4 test items (Table 8). Moreover, the symmetry score changed from 12 points (asymmetric or in need of treatment) to 6 points, (symmetric or not in need of treatment). According to the symmetry score, only 1 child was still in need of treatment or, rather, asymmetric at the endpoint of the study; however, this child also improves from 13 points to at least 10 points. The other 37 infants improved clearly toward symmetric.

The accompanying symptoms also showed an obvious reduction. The results are listed in Table 9, and only the children with autonomic disorders are regarded. In the most cases, the problems concerning spitting, sleeping, drinking, crying, defecation, feeling, and irritability improved (Table 9).

DISCUSSION

Several video-based scores^{14,22} were conceptualized for usage in routine pediatrics. The present scale serves for reviewing therapeutic results in the treatment of infantile postural and movement asymmetries, or KISS, in the context of clinical studies. The focus is the compilation of objective measurements for infants aged 3 to 6 months. The increasing facilitation of the intentional motor system between the 10th

Table 7. Validity: Comparison of the Examiner's Assessment With the Score Results

n = 26		Symmetry Score ≥ 10	Symmetry Score <10
n (%)	Need for treatment	5 (19.2)	3 (11.5)
	No need for treatment	1 (3.8)	17 (65.4)

Table 8. Pilot Study: Results of the Single Items of the Symmetry Score

Symmetry Score	Item 1		Item 2		Item 3		n = 38 Is There an Asymmetry?	Item 4	
	Active Head Rotation		Modified Frontal Righting Reflex		Head Uplifting in Prone Position			Hip Rotation: Muscular Tonus Asymmetry	
n = 38	T1	T2	T1	T2	T1	T2		T1	T2
ND: <i>P</i> value?	Yes: 0.79		Yes: 0.2		Yes: 0.2		No	12	33
Mean in °	23.05	8.05	16.61	7.32	31.34	9.82	Yes	26	5
SD in °	14 069	5742	9217	8847	18 893	10 027			
<i>P</i> value	<.001 ^a		<.001 ^a		<.001 ^a		<i>P</i> value	<.001 ^a	
95% CI	10 393-19 601		5380-13 199		15 609-27 443		Change of the MTA (hip rotation)	Better	22
								Worse	1
								Equal	15

CI, confidence interval; MTA, muscular tonus asymmetry; ND, normal distribution; SD, standard deviation; T, time point.

^a Significant.

and 14th weeks of life leads physiologically to symmetrization of postural and position control with resulting spontaneous improvements.^{7,23} Therefore, an intervention period beyond the 12th week of life was selected.

Testing of turning the head in lateral comparison and development of the prone position are among the routine pediatric examinations in infancy. A missing upraising in the prone position, with the consideration of age, is indeed not a typical criterion for postural and movement asymmetry. Nevertheless, many postural asymmetric infants show a combined deficit in development, according to their age.

The FRR aims at the examination of lateral flexion capability of the cervical vertebrae. In terms of biomechanics, this involves an indirect but sensitive testing of head rotation.²⁴⁻²⁶ Testing of the muscular tonus asymmetry and the inclined head turning routinely is performed clinically and predominantly by palpation. Only the muscular tonus asymmetry can be sufficiently visualized.

According to the KISS concept,¹ resulting asymmetries of infantile postural and movement control and muscle

tonus often result from functional disorders of the upper spinal column. Deficiency in head reclination can lead to delay in uprighting from the prone position or to prone position intolerance. Lateral flexion and rotation asymmetries of head movement accompany the classical picture of infantile torticollis and muscular tonus asymmetries. Reactive adjustment of trunk posture to head turning or lateral flexion are variable, however.⁷ Turning the head while inclined tests the biomechanical function of the upper cervical vertebrae. Thus, 6 possible test items are yielded.

Because comparable patient populations should be recruited for follow-up clinical multicenter studies, the authors selected inter-rater reliability as the primary endpoint. For the included sample size, the items “active head rotation,” “FRR,” and “uplifting from the prone position” achieved results from satisfactory up to high conformity. The inter-rater reliability for muscular tonus asymmetry was evaluated as moderate. It was retained in the final score, however, because of the noticeable to almost perfect intrarater reliability. Testing of the secondary and

Table 9. Pilot Study: Results of Accompanying Autonomic Symptoms

Are the Autonomic Symptoms Still Conspicuous (T2)?	Spitting	Sleeping	Drinking or Breast Feeding	Crying	Defecation	Feeling or Mood	Irritability
Better	17	13	15	12	6	8	16
Equal	4	1	2	4	1	0	3
Worse	4	1	1	0	1	0	0
Total (out of 38)	25	14	18	16	8	8	19

T, time point.

Note: Only the children with autonomic symptoms due to T1-measurement are regarded.

tertiary endpoints was performed to exclude distortions in the final score construction.

Intrarater reliability was selected as the secondary endpoint. The items AHROT, FRR, and head uplifting in prone position attained a satisfactory to highly reliable variation of the ICC of 0.776 to 0.988. The results for muscular tonus asymmetry lay in the noticeable to almost perfect range for Cohen's κ . Because of the lack of compliance, limited reproducibility needs to be taken into account for test-retest examinations of sensory motor performance in infancy. Significant distortions, such as with the limited reproducibility of trunk convexity, could not be determined for the 4 final test items.

Development of a difference score lent itself to construction of the final score. Thus, it was possible to clearly ascertain and follow up differences between the sides in postural and movement control. For the item uprighting in prone position, the authors determined 110° to be the reference point of a maximum head reclination and calculated the difference from the actual head uprighting.

The item was evaluated in the context of a point system. On the basis of recommendations by Streiner and Norman,²⁷ the authors developed a scale ranging from 4 points (very symmetric) to 17 points (very asymmetric). The objective items were assigned 1 to 5 points, with no priority weighting given to any single item or points. Because the qualitative assessment of the item "muscular tonus asymmetry" is a subjective measure, and the analysis of the inter-rater reliability is only to be assessed as moderate rating in the point system for this item.

Determination of a threshold value for the need for treatment (>9 points) was based on clinical experience and practical considerations for usage in therapeutic studies. To further the analysis, it is required to conduct further studies to improve the specificity of the score, even at the expense of sensitivity. For such a follow-up study, only children who show distinct postural and movement asymmetries, and thus are in need of treatment, should be accepted. Beyond this, therapeutic effects on postural and positional control must be sufficiently representable. The discrepancies in finding a consensus in the context of consultation with experts can be explained by, among other things, routine experience in the assessment of the need for treatment of infants with asymmetries. Even in comparisons of clinical examination results for 26 infants of a cross section population, with the results of the symmetry score, the examiner came to a less restrictive assessment of the indication for treatment. In only 1 case did the score deliver a false positive test result. Thus, the 4-item symmetry score fulfilled the requirements for only identifying infants in need of treatment by means of their postural and movement asymmetries.

Philippi et al¹⁴ developed a video-based score to be able to document and assess postural and movement asymmetries of infants aged between 6 and 16 weeks. Here, the

deficit in active head rotation and asymmetries of the reactive trunk posture in the prone and supine positions were determined and rated. The score achieved a high inter-rater reliability and consistency. The intrarater reliability and test-retest reliability were not reviewed. For the age group examined, only the supine position examination lent itself to being a possible examination item. Differentiated prone position examinations are often of little use because of a combined prone position intolerance of the abnormal infants in the age group the authors selected. While asymmetries in active head rotation in the supine position also proved to be reliable and valid in the present study, trunk convexity was not sufficiently reproducible.

The 4-item symmetry score aids the diagnosis therapy control for postural and movement asymmetric infants in the interventional time period between 3 and 6 months of life, which is of importance for practice. Limitation of the symmetry score is the only usage for research purposes because it is not pragmatic for use in daily routine. Nevertheless, the development was necessary to get a nearly objective measuring instrument in the pediatric manual medicine. The pilot study, conducted in preparation for a multicenter randomized and controlled study for evaluation of a single manual medical treatment for children with infantile postural and asymmetry (or KISS), showed important and distinct positive effects. The 4-item score was tested clinically and it serves for sample size calculation because of the randomized and controlled study.

Limitations

This was a small study on 1 group of patients. Further studies will need to be completed before the authors can confirm these findings applied to other groups of infants. There was no control group; thus, it is not clear to which extent sensorimotor and autonomic therapy effects of manual medicine were illustrated. As Karch et al²⁸ point out, there may also be placebo effects, so these should be considered in relation to the present findings. The impact of the recommended "tummy time" on spontaneous movement may have also influenced the results.

CONCLUSION

The 4-item symmetry score appears to be a valid and reliable tool for the diagnosis and evaluation of infants aged 3 to 6 months who have asymmetries. It is hoped that this will be a useful instrument to measure symmetry changes in pediatric research. Moreover, the combined therapy with single manual medicine and "tummy time" seems to be effective but will need to be explored further with clinical trials.

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Practical Applications

- In this study, a symmetry score for children with postural and movement asymmetry was tested for reliability and validity.
- The score may serve as a basic instrument for further research concerning manual therapy for children with symptoms associated to KISS.

APPENDIX A. SUPPLEMENTARY DATA

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jcm.2018.03.006>.

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