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Research Article

ARCHIVES OF PHYSIOTHERAPY AND REHABILITATION

The inter-rater and intra-rater reliability for measures of passive rotation of the cervical spine with a big protractor. A pre-study with a doll before performing the study with infants.

Anna Maria Ohman

Abstract

Infants with congenital muscular torticollis (CMT) often have some degree of limited rotation in the cervical spine toward the affected side. Measurement of passive range of motion (PROM) is an essential part of the examination. The aim of this study was to look for inter-rater and intra-rater reliability for measures of PROM in cervical rotation with a big protractor.

Method: Three physical therapists (PT) and one pediatric nurse participated in the evaluation of intra-rater and inter-rater reliability for PROM measurements of cervical rotation with a protractor. Three dolls were used instead of infants to exclude an unwillingness in infants that likely would restrain repeated measurements. The study was carried out in two parts, part I with a doll in real time and part II with photographs of three dolls in different positions.

Results: Both the intra-rater and inter-rater intraclass correlation coefficient (ICC) was >0.9. Inter-rater reliability was high for both the experienced and less experienced evaluators, it was however highest for the more experienced PT.

Conclusion: The reliability of measuring passive cervical rotation with a protractor was high in both intra-rater and inter-rater measurements regardless of short or long experience as a PT.

Keywords: Passive range of motion; neck rotation; infants; congenital muscular torticollis; protractor; reliability

Abbreviations

CMT: Congenital muscular torticollis; **AROM**: Active range of motion; **ICC**: Intraclass correlation coefficient

PROM: Passive range of motion; **PT**: Physical therapist; **ROM**: Range of motion; **SCM**: Sternocleidomastoid muscle

Introduction

CMT is a common musculoskeletal disorder in infants. The incidence is reported to be between 0.4-16 % [1,2]. The affected sternocleidomastoid muscle (SCM) is shorter or excessively contracted which can result in limited range of motion (ROM) in the cervical spine in rotation toward the affected side and in lateral flexion toward the opposite side. If no progress surgery is likely to be needed, it is essential to measure PROM when rotation is limited. PROM in rotation can be measured using several instruments, for example

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Citation: Anna Maria Ohman, The inter-rater and intra-rater reliability for measures of passive rotation of the cervical spine with a big protractor. A pre-study with a doll before performing the study with infants.. Archives of Physiotherapy and Rehabilitation. 8 (2025): 15-20.

Received: June 12, 2025
Accepted: June 23, 2025
Published: July 04, 2025

Ohman AM, et al., Arch Physiother Rehabil 2025
DOI:10.26502/fapr0025

a goniometer, CROM, IMU etc., [3,4,5,6,7]. However, not all are suitable for infants. A big protractor has been chosen in several studies of infants and younger children with CMT [1,8,9,10,11,12,13, 14,15]. When measuring infants with a protractor the child is lying in a supine position with the head supported beyond the edge of the supporting table. This position allows full cervical rotation, as it removes the table surface as a possible barrier to full range. Measurements should be carried out bilaterally to determine the difference between the affected and non-affected side. Reference values for cervical rotation for infants without CMT range from 100–120° (mean 110°), [13]. When measuring more than 90° the protractor has to be turned (figure 1). Usually, three persons are needed when measuring, one holding the protractor, one stabilizing the infant's shoulders and one holding the infant's head and measuring the rotation. When using a protractor with a holder only two persons are needed; the parent can stabilize the infant's shoulders while the physiotherapist holds the infant's head and measures cervical rotation. Greve et al established face validity for measuring cervical ROM with an arthrodial protractor in 2015 [16].

Figure 1: The doll in position to measure cervical rotation >90°, protractor below the head. The doll's rotation is 100° toward the left side.

Still photographs are used in other studies for measuring rotation [17] and for habitual head tilt in supine [18]. Still photographs for habitual head tilt were found to be one of two reliable tools for the assessment of cervical spine function in infants with CMT [19].

Method

Participants

Four evaluators working in pediatric care participated in the study: three physical therapists (PT) and one pediatric nurse. Two of the PTs had >25 years of experience of measuring CMT, the third PT had approximately1.5 years of experience. The nurse had assisted measurements of CMT for >10 years.

This study was carried out in two parts:

- Part I with a doll whose head was positioned in different degrees of rotation toward both the left and right side, 20 repetitions in real time. Inter-rater reliability was examined.
- Part II with 90 photographs of three dolls with the head in different degrees of rotation toward both the left and right side. Intra-rater and inter-rater reliability were examined,

In this study a protractor with a holder from Mimos was used. The protractor is marked with two 90° opposing scales in 5° increments. When measuring more than 90° the protractor has to be turned (figure 1). The dolls were lying supine with the head over the edge of the examination table. In this position the doll's head could be rotated and moved freely in all directions. In both part I and II the evaluators simultaneously, but independently of each other, noted degrees of rotation of the doll's head using the doll's nose as a marker. When the doll's nose was between different degrees they were instructed to choose the closest value. If the doll's nose was in the middle of two values the lowest was to be used (figure 2 and 3). The participants were not allowed to discuss or talk about the measuring and notes were always kept out of sight from the other evaluators.

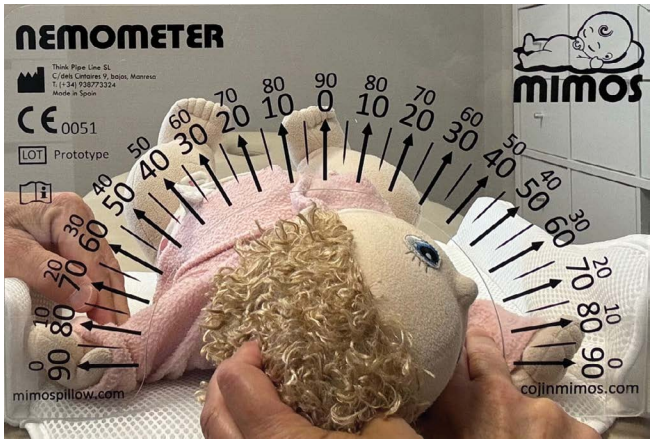

Figure 2: The doll has slightly >60° of rotation toward the right side. Noted as 60° as this is the closest value. If measurements were between values the evaluators were told to choose the lower value.

In part I, one of the participants (AO) held the doll in different positions (figure 4), and the doll's shoulders had to be ignored as it was not possible for one person to hold the head and both shoulders. The degree to which the nose pointed was noted, ignoring the position of the shoulders. In part II, photographs were taken in advance with an assistant stabilizing the doll's shoulders (figure 5).

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DOI:10.26502/fapr0025

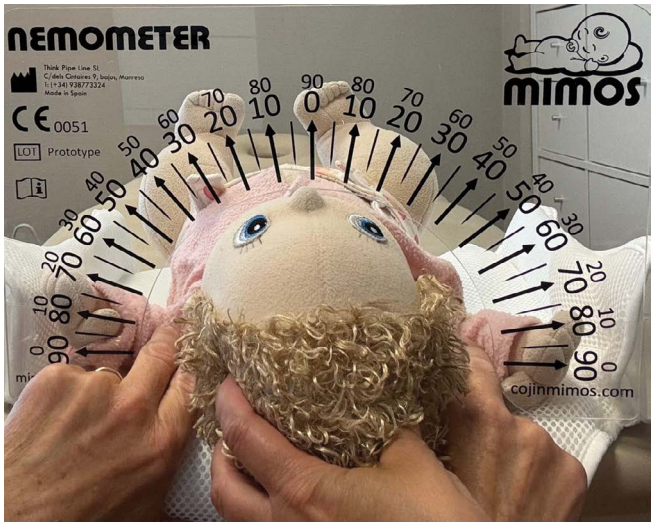

Figure 3: The doll has slightly >0° of rotation toward the left side. Noted as 0° as this is between 0 and 5°, if measurements were between values the evaluators were told to choose the lower value.

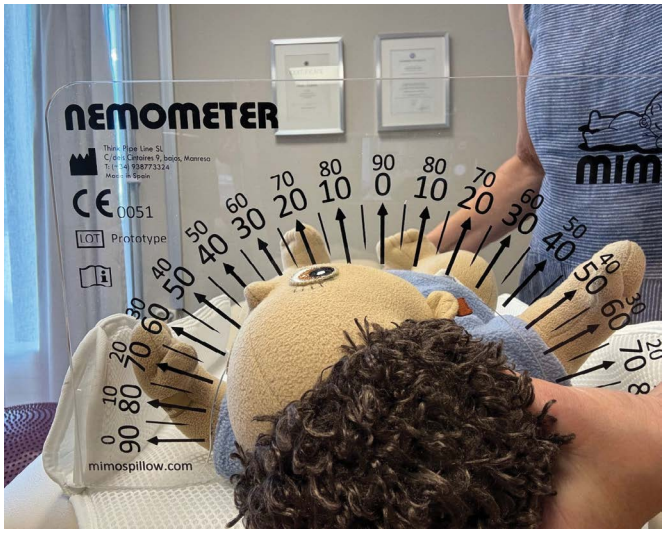

Figure 4: The doll has 40° rotation toward the left side. Position of the shoulders ignored in part I of the study.

Part II. All four evaluators participated. The rotation degree was noted for 90 photographs, and all were evaluated twice with a break between measurements and with the photographs in random order.

Statistics used: ICC, absolute agreement and strict calculation of scores (Mangold, Pascal (2018). ICC calculation software, based on Wirtz & Caspar 2002).

Results

Part I

The ICC for inter-rater reliability was 0.991. Of twenty measurements in real time, eleven measurements had no disagreement, in eight measurements one of three evaluators had a disagreement of 5°, and in one measurement, all three evaluators had a disagreement range of 10° between the lowest and highest value (table 1).

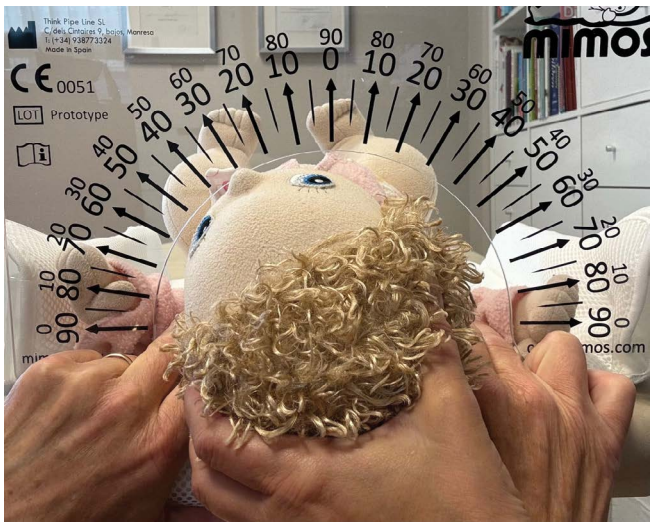

Figure 5: Doll with stabilized shoulders, measuring with the protractor gives 30° rotation toward the left side.

Part II

The ICC for inter-rater reliability was 0.995. Intra-rater reliability was high for all evaluators with an ICC of more than 0.99, and measurements with agreement ranged from 86.8% to 96.8 %. The most experienced evaluators had an ICC of 0.997 and the less experienced 0.991 (table I).

Table I In part II the evaluators had an intra-rater result agreement ranging from 86.8 to 96.8 %. The most experienced PT had the highest agreement percent and the less experienced PT the lowest agreement percent.

Evaluators	Percent with agreement	ICC for intra-rater reliability
PT with most experience	96.8	0.997
PT with next most experience	90	0.997
Pediatric nurse	88	0.995
PT with less experience	86.8	0.991

In part II the evaluators had an intra-rater result agreement ranging from 86.8 to 96.8 %. The most experienced PT had the highest agreement percent and the less experienced PT the lowest agreement percent.

Discussion

Both intra-rater and inter-rater reliability were high in this study. An ICC above 0.9 is generally considered as excellent [20]. The instrument is marked in intervals of 5° and deciding the degree of rotation may be the easy part. A problem when testing a measuring tool designed for infants is that infants with CMT are often unwilling to participate

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DOI:10.26502/fapr0025

in repeated measurements, especially experienced when measuring PROM in rotation of the cervical spine. Making an infant relaxed enough to tolerate complete rotation toward the affected side is a challenge. In a study situation, the infant may restrict motion and change head position before all evaluators have noted the PROM. Using photographs of infants may be better when measuring the degree of rotation and not variability in infant cooperation. For this reason, a doll was used instead. We were not able to restrict the doll's cervical motion and for that reason all evaluators could not measure the doll and expect to get fair measurements. In part I of the study with a doll held in different positions, we could calculate inter-rater reliability but not intra-rater reliability. For intra-rater reliability in part II we used photographs of the dolls in different positions. Still photographs have been used for habitual head tilt among infants [18] and also for testing reliability on the muscle function scale (MFS) [21], both found to be reliable tools for infants with CMT [19].

Both experienced and less experienced examiners may be expected to have a high reliability of observing the degree of cervical rotation with a protractor. In a clinical setting, it is important to distinguish between the infant's unwillingness to cooperate in PROM and a real endpoint. The infant has to be relaxed and distracted when measuring to gain optimal PROM.

Klackenberg et al did not measure with the head over the edge of the examination table [17]. Neither did Greve et al, as they used a stable surface when measuring PROM in rotation due to limited staff [16]. It is expected that the cheek reaches the surface before endpoint at least in the non-affected side and at best about 70° in the affected side. Infants normally have >90° of rotation in the cervical spine, therefore an inability to measure >70° is not good enough. Reference values for normal PROM in rotation are in the range 100 –120° (mean 110°) (13). According to APTA's guidelines, the discharge of infants with CMT demands that five criteria are met: PROM within 5° of the non-affected side; symmetrical active movement patterns; age-appropriate motor development; no visible head tilt; and the parents/caregivers understand what to monitor as the child grows [22]. If full PROM in rotation cannot be measured because of the surface, it is difficult to determine the real difference between the affected and non-affected side.

Seager et al 2020 tested reliability of visual estimation in AROM in cervical rotation using video recordings [23]. Videos are more clinically realistic and it is worth testing if enough good videos can be taken for PROM with a protractor. This may be an option to photographs if the PT performing the rotation can avoid getting in the way of the camera.

In this study a protractor from Mimos was used, specially designed for measuring infants with CMT and so constructed that only the parent and PT are needed for measuring. Using a protractor with a holder minimizes the risk that the protractor is not in alignment. Hand holding the protractor demands a third person and it can be challenging to hold it totally in line. Some protractors have a built-in leveling bubble to ensure accuracy but still need an extra person when measuring. Greve et al showed that when an extra person is needed, a stable surface is often chosen [16]. This gives at most about 70°, however it cannot be expected that the non-affected side has less than 90° [13].

Choice of measuring instrument and the position used during the measurements must be considered to get as adequate a ROM as possible. Arbogast et al 2007 found that active ROM in rotation increased from 3 to 12 years of age. It must be taken into consideration if a three-year-old child can cooperate in active measures as well as an older child, especially with an instrument on their head and belted in a chair [3]. Children have consistently greater ROM in the cervical spine than adults [4]. PROM in cervical spine rotation is shown to decrease by age, the mean at infanthood is 110° and at age 3.5–5 years it is 100° [13,14]. In addition, AROM in rotation in older children and adults decreases [24,25]. It is a challenge to measure true ROM in infants with CMT, AROM is probably a little more difficult than PROM as you can't instruct an infant to do as best they can. However, Seager found overall excellent intra-rater reliability for AROM of cervical rotation and good inter-rater reliability [23]. Castle et al found in their study a measurement method for AROM in cervical rotation, comparing 2D and 3D analyses with good results [26].

Limitations

The three dolls had a seam in the middle or close to the middle of the nose. It is possible that the evaluators had a slightly different opinion of where the middle of the nose was. A mark on the nose could have solved that issue.

Future plans

Next step will be to measure PROM in rotation in a study with infants and try video recordings instead of photographs. Videos are more dynamic and clinically realistic than still photographs. Choosing videos is a balance between being realistic and practical (23).

Conclusion

Measuring cervical rotation with a protractor gives high inter-rater and intra-rater reliability. Using a protractor with a holder is more practical as it demands the involvement of fewer people. The challenge with measuring infants is to get them relaxed and cooperative. A study of real infants with video recordings could confirm reliability.

Citation: Anna Maria Ohman, The inter-rater and intra-rater reliability for measures of passive rotation of the cervical spine with a big protractor. A pre-study with a doll before performing the study with infants. Archives of Physiotherapy and Rehabilitation. 8 (2025): 15-20.

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DOI:10.26502/fapr0025

Acknowledgments

I am very grateful to my colleagues Annika Kjellström, Eva-Lott Mårdbrink and Vincent Franklind for their time and patience when participating in this study. Thanks to Erik Öhman who helped stabilize the doll's shoulders when taking photographs.

Funding:

This case report received no external funding.

Institutional Review Board Statement:

Ethical review and approval were waived for this study, due to the Swedish Ethical Review Authority Statement: "If the intended publication contains only accounts of diagnosis and treatment, or of some other course of events, this practice should be understood not to be a matter of research that must be ethically tested" (https://etikprovningsmyndigheten.se/faq/kravs-etikprovning-for-fallrapporter/).

Conflicts of Interest:

The author declares no conflicts of interest.

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DOI:10.26502/fapr0025

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