

# The range of motion of the cervical spine in children aged from 3 to 7 years — an electrogoniometric study

Jacek Lewandowski, Paweł Szulc

Department of Functional Anatomy, Academy of Physical Education, Poznań, Poland

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*The aim of the study has been to evaluate the range of motion of the cervical spine in relation to the age of the participants, and to determine the dimorphic and asymmetrical differences in the range of motion in pre-determined age categories. The study involved 300 children (150 girls and 150 boys) aged from 3 to 7 years, and tensiometric electrogoniometry was used to evaluate the range of cervical spine motion. The highest amplitude of cervical spine motion could be observed in the transverse plane and this was followed by that of the sagittal plane, with frontal plane motion being the lowest. The dynamics of the cervical spine motion changes were characterised by the presence of two distinct periods of motion increase — between years 2 and 3 and between years 6 and 7; the other periods were characterised by a decrease in cervical spine motion. The dimorphic and asymmetrical differences proved statistically insignificant.*

**key words:** cervical spine, range of motion, electrogoniometry, child

## INTRODUCTION

Tensiometric electrogoniometry is one of the most sophisticated methods used for the evaluation of spinal curvatures and spinal segmental motion. Tensiometric electrogoniometry enables measurement to be performed independently of the location of the joint axis. The method is also characterised by a high degree of reliability and accuracy of the results as compared to invasive radiological measurements [unpublished data].

The available reports from studies investigating cervical spine motion have focused predominantly on the adult population [1–4, 6, 7], but so far there have been no studies targeting early childhood populations, such populations being important because of the changes in bodily proportions which occur at this age period. In view of this, the aim of this study has been to evaluate cervical spine motion in relation to the age and sex of the participants. The results may prove contributory both in diagnostics and

in screening studies focusing on the pathology of cervical spine motion.

## MATERIAL AND METHODS

The study involved 300 children (150 girls and 150 boys) aged 3–7 years. A Penny & Giles tensiometric electrogoniometer (Biometrics Ltd) was used to evaluate the range of cervical spine motion and the research methods were the same as those proposed by the authors [5]. The results of the study were submitted for statistical analysis and the research population was divided into 5 developmental periods (age categories).

## RESULTS AND DISCUSSION

The analysis of the functional characteristics revealed a high amplitude of cervical spine motion in all three anatomical planes (Table 1). The range of flexion was found to decrease in girls aged from 3 to 5, with the highest motion deficit observed be-

**Table 1.** Statistical presentation of somatic and functional features in the analysed population of children

Age	Body mass	Body height	Flexion	Extension	Lateral bending left	Lateral bending right	Axial rotation left	Axial rotation right
	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD
<b>Male</b>								
3	17.1 ± 1.8	100.1 ± 3.8	68.1 ± 8.0	69.6 ± 6.4	36.2 ± 9.0	35.6 ± 9.3	74.3 ± 6.0	74.1 ± 5.3
4	18.9 ± 2.1	107.3 ± 5.1	58.4 ± 6.3	67.1 ± 5.2	41.3 ± 6.5	41.5 ± 6.5	76.4 ± 8.1	76.6 ± 8.1
5	21.5 ± 2.4	114.4 ± 5.9	60.4 ± 4.8	65.4 ± 4.6	38.3 ± 7.1	38.0 ± 7.6	78.8 ± 6.2	78.4 ± 6.5
6	24.1 ± 3.1	121.2 ± 5.3	61.9 ± 9.8	66.8 ± 7.3	38.9 ± 7.9	38.5 ± 8.3	74.3 ± 3.9	73.9 ± 4.1
7	26.6 ± 4.2	128.4 ± 5.9	60.1 ± 7.9	63.9 ± 6.9	44.8 ± 6.3	44.4 ± 6.6	75.5 ± 5.8	75.1 ± 5.9
<b>Female</b>								
3	16.7 ± 1.9	99.6 ± 3.9	60.9 ± 8.0	68.8 ± 6.4	35.8 ± 9.0	35.5 ± 9.3	70.3 ± 6.0	70.4 ± 5.3
4	18.4 ± 2.2	106.5 ± 4.7	56.8 ± 6.3	59.9 ± 5.8	46.5 ± 6.7	46.5 ± 7.1	74.7 ± 5.6	74.5 ± 5.8
5	20.8 ± 2.3	114.1 ± 4.9	55.7 ± 5.1	58.1 ± 5.4	48.3 ± 6.3	48.6 ± 6.4	76.7 ± 7.5	77.2 ± 6.3
6	23.2 ± 2.5	120.3 ± 4.6	58.9 ± 9.7	60.4 ± 7.5	44.6 ± 7.5	44.6 ± 8.2	73.1 ± 6.5	73.1 ± 6.3
7	25.8 ± 4.4	126.8 ± 5.4	61.4 ± 7.8	57.8 ± 6.9	50.1 ± 5.8	49.7 ± 6.2	74.9 ± 6.9	75.2 ± 7.0

tween years 3 and 4. In successive age periods the cervical spine motion was found to increase. The range of flexion was also found to decrease in boys aged 3 to 4, only to increase slightly in the two successive age categories and to decrease again in the last of the developmental periods analysed. Similar trends could be observed when analysing cervical spine extension. Mean motion values between years 3 and 7 decreased in both sexes, in girls by 11° and in boys by 5.7°. The dynamics of cervical spine motion changes were similar for both sexes, and motion deficit could be observed, which was particularly pronounced in girls (a reduction of 10.7°). Changes in motion in the sagittal plane observed in consecutive developmental periods may be related to the dynamics of changes in the cervical lordosis angle. The higher values obtained in our studies, as compared to studies on adult populations, may be indicative of the lability of the cervical lordosis caused by the weaker tone of the spine-supporting muscles [1–4, 6].

In girls the mean values of left lateral bending of the cervical spine increased in the age period analysed by 14.3°, and in boys by 8.6°. The dynamics of the spine motion changes in girls seem to be characterised by two periods of spine motion increase, between years 3 and 5, and between years 6 and 7 ( $p \leq 0.01$ ). In boys, the motion increased during the first and the last developmental period by about 5°. Similar trends could be observed when analysing right lateral bending of the cervical spine. Between years 3 and 7 the motion increased by 14.2° in girls

and by only 8.8° in boys. The pace of development was found to be analogous to the motion in the opposite direction, and the increments in motion in specific age categories were comparable with one another. The range of lateral movement as measured through radiological examination [6] and measured by potentiometric goniometry [2, 4] amounts to about 45° to either side. Mean values from our studies are comparable with those reported for adult populations.

The highest amplitude of cervical spine motion was seen in the transverse plane. In both sexes the dynamics of the axial rotation was characterised by two periods of motion increase, between years 3 and 4 and years 6 and 7. The absolute values of the motion range proved higher in the male population, yet the difference between the sexes was statistically insignificant. The overall rotation range results in the population of children analysed were comparable to the results obtained for adult populations [6, 7].

The absolute value differences between sexes and body sides were statistically insignificant.

## REFERENCES

1. Castro WHM, Sautmann A, Schilger M, Santman M (2000) Non-invasive three-dimensional analysis of cervical spine motion in normal subjects in relation to age and sex. *Spine*, 25: 443–449.
2. Chen J, Solinger AB, Poncet JF, Lantz ChA (1999) Meta-analysis of normative cervical motion. *Spine*, 24: 1571–1578.

3. Dvorak J, Antinnes JA, Panjabi M, Loustalot D, Bonamo M (1992) Age and gender related normal motion of the cervical spine. *Spine*, 17: 393–397.
4. Feipel V, Rondelet B, Le Pallec JP, Rooze M (1999) Normal global motion of the cervical spine: an electrogoniometric study. *Clin Biomech*, 14: 462–470.
5. Lewandowski J, Szulc P, Marecki B (1999) Electrongoniometric measurements of motion ranges in spinal joints. *Folia Morphol*, 58 (Suppl. 1): 1.
6. Penning L (1978) Normal movements of the cervical spine. *Am J Roentgenol*, 130: 317–326.
7. Penning L, Wilmink JT (1987) Rotation of the cervical spine. A CT study in normal subjects. *Spine*, 12: 732–738.