Femoral Neck Shaft Angle In Relation To Spasticity In Childern With Spastic Hemiplegic Cerebral Palsy

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Abstract

Background: *Femoral neck-shaft angle (NSA) is the measurement of the angle formed between the oblique oriented neck with the vertical shaft and is an important anatomic measurement for the evaluation of biomechanics of hip. Spasticity is a muscular hypertonicity characterized by a velocity-dependent increased resistance to stretch, which interfere with voluntary movement.* ***Subjects****: Fifty children with hemiplegic cerebral palsy of both genders with age ranged from 3to 10 years participated in this study. They were selected from El-Bagour general hospital, Ashmoun general Hospital and care scan private center in El-Menoufia Governorate.* ***Purpose****: This study was conducted to core late femoral neck shaft angle measurement with spasticity in children with hemiplegic cerebral palsy.*

Materials: *Antero posterior x-ray beams of pelvis, Modified ashowrth scale, Sante dicom software and AutoCAD 2014 software*

Results: *There was a significant increase in the neck shaft angle of the affected side compared with that of the non-affected side in both genders. There was a moderate positive significant correlation between femoral neck shaft angle and spasticity.*

Conclusion: *The femoral neck shaft angle significantly decreases with aging particularly in non-affected side. As the degree of spasticity increases, and neck shaft angle reaches to higher degrees affecting hip geometry. The gender doesn't directly affect (NSA).*

Keywords: *Hemiplegic cerebral palsy, Neck shaft angle, spasticity.*

I. Introduction

Cerebral palsy (CP) is the most common developmental disorder associated with lifelong motor impairment and disability. This disorder results from insult or injury to the brain before birth or in early childhood that causes neural connections to be formed in aberrant ways and leads to persistent abnormal limb strength, control, or both[(1)].Hemiplegic cerebral palsy (HCP) is a form of spastic CP in which one arm and leg on either the right or left side of the body is affected. Children with hemiplegia characterized by upper limb is greater affected than lower limb.[(2)]. The upper limb is typically more affected than the lower limb, and both tend to have more distal involvement than proximal involvement. Spasticity associated with HCP can lead to musculoskeletal complications such as contractures, pain, and subluxation. Primary or secondary abnormalities within the spinal cord can increase spasticity, and peripheral nociception (pain) can also exacerbate it. Ultimately, the clinical manifestations of the neurological injuries depend on the extent and type of CNS damage, the location of the irreversible insult, and the ability of the CNS to adapt or re organize after the insult [(3).] Muscle spasticity on the affected side decreases muscle and bone growth, resulting in decreased range of motion (ROM). Therefore, children with hemiplegia often present with contractures and limb-length discrepancies on the involved side[(4)]. The affected side of the child with hemiplegia often presents with shoulder protraction, elbow flexion, wrist flexion and ulnar deviation, pelvic retraction, hip internal rotation and flexion, knee flexion, and forefoot contact only due to plantarflexed foot[(5)]. The femur is the longest & strongest bone in the body. Its length is associated with a striding gait, its strength with the weight and muscular forces which it must withstand. Its shaft is almost cylindrical. It has a proximal rounded articular head projecting medially from its short neck. The femoral neck length is approximately 5cm long and connects the head to shaft to form femoral neck shaft angle (NSA). This angle facilitates movements at the hip joint, enabling the limb to swing clear of the pelvis[(6)]. The neck shaft angle is formed by two axes, the neck axis whichis the line drawn from the center of the femoral head to the center of the femoral neck at the narrowest part of the neck,the long axis of the femur which is defined as the line drawn from the middle of the femoral condyles to the middle of the greater trochanter [(7)] The femoral neck shaft angle is wide in infancy when the child learns to walk and gradually decreases during growth.It is very high (150°) in neonatal modern humans and then gradually decrease during development, reaching adult values during adolescence. The neck shaft angle minimally decreases to a more varus orientation of the femoral neck during development depending on the assumption of normal weight-bearing through the hip region and increasing locomotor activity levels during development[7].This study aimed to provide understanding the relationship between Femoral neck shaft angle and spasticity that could eventually help in developing treatment regimens, address gait deviations at the correct level and promote normal bone growth in children with CP.

II. Material and methods

A. Study *Design:* Cross sectional correlation study

B.*Participants:*

Fifty children from both sexes (boy and girls) diagnosed as spastic HCP were included in the study. Their ages ranged from 3 to 10 years. They were recruited from two hospitals and one medical radiological center in El Menoufia Governorate, El bajur, Ashmoun general hospitals and Care scan medical center respectively. The current study approved by the Ethics Review Committee No:012/001413 of the Faculty of Physical Therapy, Cairo University. Prior to data collection, the purposes, procedures and benefits fully explained to the parents of the participating children. All children's parents gave their informed consents to have their children participated in the study. The current study conducted from January 2017 till July 2018. All target population of the study diagnosed as Hemiplegic CP. Only Children excluded from the study if they diagnosed as (Visual or auditory problems, Epilepsy, Mental retardation, autistic features or fixed deformity related to the joints of the lower limbs)

C. Methods:

Modified ashowrth scale (MAS)**,** X-ray Beams**,** Santedicom software**,** AutoCAD 2014 software**.**

D.*Measurements procedures:*

1.Modified ashowrth scale (MAS): Modified Ashworth' Scale is used to measure the degree of spasticity in pediatrics and adults that shows upper motor neuron disorders [8].

2.Anteroposterior X-ray Beams of Pelvis: The anteroposterior pelvic radiograph was made with the patient supine on the x-ray table with both lower extremities oriented in 15° of internal rotation in order to maximize the length of the femoral neck. The x-ray tube-to-film distance should be 120 cm, with the tube oriented perpendicular to the table. The crosshairs of the beamare centered on the point midway between the superior border of the pubic symphysis and a line drawn connecting the anterior superior iliac spines. (9)

3. Sante dicom software: DICOM is defined as the digital imaging and communications in medicine. DICOM was created by the National Electrical Manufacturers' Association (NEMA) in order to improve compatibility and workflow efficiency between imaging systems, medical devices, and other information systems used in a hospital environment. This has become the principal standard for the communication of medical images and is now implemented by virtually all medical imaging equipment manufacturers(10).

4.AutoCAD 2014 software: A three dimensional (3D) human modeling program version ,2014 has been developed to work in conjunction with computer aided design software, AutoCAD. The program allows the creation and manipulation of variable size ,3D human models and provides the flexibility of a professional CAD system. the special feature of the program and its application in workstation design are described and illustrated with examples. This program operates on a personal computer and provides a low cost but effective alternative to main -frame based similar systems (11).

D. *data analysis:*

Descriptive statistics were conducted to calculate the mean, standard deviation and the frequency all the measured variables. Paired t test was conducted for comparison of neck shaft angle between the affected and non-affected sides. T test was conducted for comparison of neck shaft angle between boys and girls. Spearman Correlation Coefficient was conducted to determine the correlation between spasticity grades and neck shaft angle. Person Product Moment Correlation Coefficient was conducted to determine the correlation between age and neck shaft angle. The level of significance for all statistical tests was set at $p < 0.05$. All statistical measures were performed through the statistical package for social studies (SPSS) version 19 for windows.

III. Results

This study was conducted on 50 hemiplegic children from both genders to investigate the effect of spasticity on the femoral neck shaft angle among children with spastic hemiplegic cerebral palsy.

A. Descriptive Statistics:

Fifty children with spastic hemiplegic cerebral palsy participated in this study. Their mean ± SD age was 5.68 ± 2 years with maximum value of 10 years and minimum value of 3 years.

1. **<u>Sex distribution:</u>**

The sex distribution of the study group revealed that there were 27 girls with reported percentage of 54% while the number of boys was 23 with reported percentage of 46%.

2. **<u>Spasticity grades distribution:</u>**

The spasticity grades distribution of the study group revealed that there were 7 (14%) children with grade I, 22 (44%) children with grade I^+ , 17 (34%) children with grade II and 4 (8%) children with grade III.

B.Inferential Statistics:

1. **Comparison of neck shaft angle between the affected and non-affected sides:**

There was a significant increase in the neck shaft angle of the affected side compared with that of the non-affected side. (table 1).

Table 1. ***Comparison of mean value of neck shaft angle I between the affected and non-affected sides.***

Item \ Affected side	Affected side	Non-affected side	MD	t- value	p-value	Sig
	$\bar{X}$ ±SD	$\bar{X}$ ±SD				
Neck shaft angle (degrees)	152.04 ± 6.47	141.68 ± 3.86	10.36	10.4	0.0001	**S**

$\bar{X}$: Mean **SD: Standard deviation** **MD: Mean difference**

t value: Paired t value **p value: Probability value** **S: Significant**

2. Comparison of the neck shaft angle between girls and boys:

There was no significant difference in neck shaft angleof both affected and non-affected sides between girls and boys. (table 2).

Table 2. ***Comparison of the neck shaft angle between girls and boys:***

Neck shaft angle (degrees)	Girls	Boys	MD	t- value	p-value	Sig
	$\bar{X}$ ±SD	$\bar{X}$ ±SD				
Affected side	151.22 ± 7.29	153 ± 5.35	-1.78	-0.96	0.33	**NS**
Non-affected side	141.33 ± 4.39	142.08 ± 3.17	-0.75	-0.68	0.49	**NS**

$\bar{X}$: Mean **SD: Standard deviation** **MD: Mean difference**

t value: Unpaired t value **p value: Probability value** **NS: Non-significant**

3. Relationship between spasticity grades and neck shaft angle:

The correlation between spasticity grades and neck shaft angle was moderate positive significant correlations.(Table 3).

Table 3.*Correlation between spasticity grades and neck shaft angle:*

Neck shaft angle (degrees)	r value	p value	Sig
Spasticity grades	0.5	0.0001	**S**

r value: Spearman correlation coefficient p value: Probability value S: Significant

4. Relationship between age and neck shaft angle:

The correlations between age and neck shaft angle were strong negative significant correlations in the affected side and also strong negative significant correlations in the non-affected side. (Table 4).

Table 4. *Correlation between age and neck shaft angle:*

	Neck shaft angle (degrees)	r value	p value	Sig
Age (years)	**Affected side**	-0.81	0.0001	**S**
	Non-affected side	-0.87	0.0001	**S**

r value: Pearson correlation coefficient p value: Probability value S: Significant

5. Spasticity gradesandneck shaft angle:

There was a significant difference between the four grades in the mean value of neck shaft angle (Table 5).

Table 5. ***Comparison of neck shaft angle betweenchildren with spasticity grades of I, I^{+}, II and III:***

Neck shaft angle (degrees)				F- value	p- value	Sig
$\bar{X}$ ±SD						
Grade I (n=7)	**Grade I^{+} (n=22)**	**Grade II (n=17)**	**Grade II (n=4)**			
152.28 ± 4.15	148 ± 5.68	155.3 ± 5.14	160.5 ± 1.73	10.63	0.0001	**S**

Multiple comparison (Tukey)

	MD	p- value	Sig
Grade I - GradeI^{+}	4.28	0.21	**NS**
Grade I - Grade II	-3.02	0.56	**NS**
Grade I - Grade III	-8.22	0.06	**NS**
GradeI^{+} - Grade II	-7.3	0.0001	**S**
GradeI^{+} - Grade III	-12.5	0.0001	**S**
Grade II - Grade III	-5.2	0.27	**NS**

$\bar{X}$: Mean **SD: Standard deviation** **MD: Mean difference**

p value: Probability value **NS: Non-significant**

IV. Discussion

The femoral neck-shaft angle is of highest clinical relevance for orthopedic and trauma surgeons and remains to be a subject of interest in current research. The measurement of femoral neck shaft angle is common for studies involving correlations with congenital hip dislocation, slipped capital femoral epiphysis, risk of osteoarthritis, femoral neck fracture, and instability of the hip(12).

Shivashankarappaet al.,(6)revealed that the mean value of femoral neck shaft angle is large during infancy, and decreases with age, this finding matches with the presentstudy.

Concerning to gender, the sex distribution of this study group revealed that there were 27 girls with reported percentage of 54% while the number of boys was 23 with reported percentage of 46%. There was no significant difference in neck shaft angle of the affected side between girls and boys (p = 0.33) and in the non-affected side, there was no significant difference in neck shaft angle between girls and boys (p = 0.49) and the result of the present study is in consistent with Gilliganet al., (14) whom reveled that there was no sex difference in value of femoral neck shaft angle in adults.On the other hand, Mohamad et al.,(15) revealed that mean value of neck shaft angle was smaller in females than males meaning that the angle is higher in males than females and this result mismatches with the finding of this study regarding to gender.Nissen et al., (16)studied femoral neck shaft angle in 249 healthy adults using (AP) x-ray beams years and found that the angle is significantly higher in males compared to females. Nissen et al., (17) correlated neck shaft angle measurements with body mass index and osteoporosis. These parameters hadn’t been discussed in this study.

Regarding to the correlations between the age and (NSA) value, there were strong negative significant correlations in the affected side (r = -0.81, p = 0.0001) and also strong negative significant correlations in the non-affected side (r = -0.87, p = 0.0001). Gilliganet al., (14)correlated femoral neck shaft angle to climate, gender, life style and side and they found there was no sex difference, no age-related change in adults, the neck shaft angle values were higher in warmer regions than in regions where ancestral populations were exposed to colder conditions, in Europe (126°) and the Americas (125°),they also found that the neck shaft angle values were higher in agricultural and urban lifestyle than sedentary life style, according to side there was a small lateral difference which could be due to right leg dominance.The decline in NSA in children is influenced by dynamic forces produced during upright walking. Therefore, the magnitude of the angle is attributed to appropriate motor control, muscle balance and ligament integrity.

Huser, Mo and Hosseinzadeh, [17] whom stated that asymmetrical muscular spasticity is thought to be one of the primary drivers of hip displacement in children with CP. Several altered components in dysplastic hips can be observed in the proximal femur and acetabulum. Abnormalities seen with the proximal femur are anteversion of the femoral neck in the transverse plane, coxa valga (increased neck–shaft angle), and dysplastic and degenerative changes. These results come in agreement with current result that also proved that there was a moderate positive significant correlation between spasticity grades and femoral neck shaft angle meaning that spasticity may affect neck shaft angle and therefore affecting devolving hip joint.

V. Conclusion

From the obtained results of current study, it can be concluded that femoral neck shaft angle of children with spastic hemiplegia significantly decreases with aging.The decrease is obvious in non-affected sides more than affected ones. As the degree of spasticity increases, and neck shaft angle reaches to higher degrees affecting hip geometry.

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