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Original Research Article

Postural assessment of children with spastic cerebral palsy: a cross-sectional study

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ABSTRACT

Background: Children with cerebral palsy (CP) exhibit gait difficulties, posture alignment issues when standing, and issues with body orientation in space as a result of both primary and secondary CP deficits. The purpose of this study was to analyze the posture of children with spastic diplegic CP.
Methods: The 17 subjects of age group 3-10 years with GMFCS scale I-II of CP were taken in the study and compared with age matched control group of 17 typical development (TD) children. The postural assessment was carried out using the photographic method. Angles like the head angle, angle of hip joint, angle of ankle joint were calculated with the help of Matlab script.
Results: The Pearson's correlation was utilised to examine the relationship between various postural angles in the CP group while the t-test was used to analyse differences between the two groups. The two groups were found to differ in every measure but horizontal alignment of acromion (HAAC), angle of hip (AH), angle of knee (AK), angle of ankle (AA), scapular alignment right and left (SAR) (SAL) were significantly different in CP group rather than TD group ($p<0.01$) and postural angles were found to be significantly correlated in CP group ($p<0.01$).
Conclusions: The postural angles in children with spastic CP are deviated from the normal angle. Correct analysis of posture gives us a tool to identify the altered biomechanics and further design an intervention program which will address the mal-aligned structures.

Keywords: CP, Diplegia, Posture, Spasticity

INTRODUCTION

Correct upright posture is defined as having the spinal segments and every other part of the body in their most optimal orientation with respect to the segment next to it and the complete trunk. One of the signs of a healthy musculoskeletal system is an upright posture. Compared to children who are developing normally, children with CP usually have an unusual spine alignment.[1] Alignment and vertebral growth can be prejudiced by key impairments, like abnormal muscle tone and secondary issues that comprises skeletal abnormalities in the lower extremities.[2] Early detection and avoidance of body alignment asymmetries helps control posture in children with disability.

Children with CP have access to standardized clinical examinations of body segment alignment such as posture and posture ability scale (PPAS), seated postural control measure (SPCM), spinal alignment and range of motion measure (SAROMM), and clinical assessment of body alignment (CABA).[3] But there is no established protocol for posture analysis. Several techniques have been developed during the past ten years for performing more precise postural examinations. There are a number of manual techniques, including the use of goniometers, flexible rulers, and line-of-gravity observational posture analysis.[4] But using these approaches makes it impossible to get quantifiable data. As a result, slight postural changes cannot be seen.[5] Radiography, 3-D motion analysis with help of electromagnetic and optical tools, the Formetric instrumentation system, Moiré topography, spinal mouse are some of the approaches available for the objective examination of spine position. But they are rarely employed since it necessitates costly lab setups.[4,6,7]

The most popular technique for noninvasive postural measurements that analyse the posture of the spine using anatomical reference points is photogrammetry. This measurement is digital, valid, and reliable. Using software made exclusively for this purpose, photogrammetry calculates the linear distances and angles (formed between body markers and lines produced by horizontal or vertical lines) in digital pictures to evaluate postural alignment.[8] It is very portable, reasonably inexpensive, and only needs a camera, markers, and sticky tape. It also allows for the simultaneous assessment of multiple posture angles. This makes it a common tool in both field and clinical research.[9] Numerous research examined the validity and dependability of photogrammatry in adults and adolescents.[4,8,10] The interobserver agreement between visual and photogrammetry postural evaluation was compared in a study by Lunes et al on 21 individuals, and they came to the conclusion that postural assessment by photograph would be the gold standard. The positioning of the markers was this assessment's distinctive feature. Markers were not placed separately for each physiotherapist, which would have allowed for the examination of the true intercorrelation of assessments.[11]

Pausic et al demonstrated that a photographic technique for assessing standing posture in elementary schoolchildren had a satisfactory level of interitem reliability.[12] The Photographic posture analysis may be a promising approach to gauge children's and teenagers' posture in light of these findings. The Photographic posture analysis have only been the subject of a very small number of studies in CP, despite the fact that numerous studies have been conducted on children and adolescents who are developing normally.

This study's major goal was to evaluate posture of children with spastic CP and compare their postural angles with healthy children.

METHODS

This study was carried out from March to June 2023 at the SGT university's outpatient department of physiotherapy in Gurugram, Haryana, India.

Study design

The current study was designed as a cross-sectional study. The study was approved by the university's ethics committee (SGTU/FPHY/2022/438). The goals and methods of the study were explained to each participant as well as their parents and a formal written consent was received from them.

Participants

Using G Power software version 3.1, the sample size was estimated. The independent t-test was used as the analyses' test to determine the mean difference between two independent groups, and the sample size was 34. The power was 0.70, the alpha error was 0.05, the effect size was 0.90, and it was two-tailed.

The study comprised seventeen children with spastic CP (13 boys and 4 girls) who were referred by pediatric neurologists. A diagnosis of CP (spastic diplegic), being between the ages of 3 and 10, having motor function defined as levels "I, II" by the gross motor function classification system (GMFCS), being able to stand alone, and understanding all spoken instructions were the inclusion requirements. Spinal surgery, botulinum toxin (BoNT), and surgical treatment received within the previous six months were excluded criteria. Another neurodevelopmental or congenital illness other than CP was also excluded.[8] We asked a sample of seventeen children (10 boys and 7 girl) who were age- and sex-matched, had TD, and had no known neurological or orthopedic conditions to take part as reference values.

Postural evaluation

To ensure that every subject was positioned the same way in front of the camera, landmarks were laid out on the ground. The cameras were Nikon DSLR 7100 digital cameras. Three tripods were used to position the cameras 200 cm away (one tripod at front, other at the back and third one on the right side of subject) from the line designating the subject's location. A spirit level was used to level it on the stand so that it was parallel to the ground. The tripod's height was set so that the center of the Nikon 20 mm wide-angle lens was at the eye-level of child. Before taking photos, the researcher placed reflective markers of 16mm diameter on the subject's left and right side of body at the following anatomical points: lateral canthus of eye, tragus of ear, anterior superior iliac spine (ASIS), posterior superior iliac spine (PSIS), knee joint line, greater trochanter, glabella, mention, lateral malleolus, medial malleolus, ear lobe, acromion, inferior angle of the scapula, transition point between the medial border and spine of scapula, spinous process of C7, T12, L3, S2. Of these 18 points, 12 bilateral. Individual was instructed to establish a comfortable habitual standing position, look straight ahead, and stand on the appropriate spot facing the front camera after the markers had been placed.[12] The researchers took three pictures of each child standing with their feet on the ground, one from the front, one from the back, and one from the right side.

For the photogrammetry, the following angles were calculated:

In Figure 1 picture of angles in different views.

Head angle: It is the line drawn from canthus to tragus line in relation to the vertical.[10]

Thoracic inclination: The angle is set up by line of C7 to T12 with regard to vertical.[10]

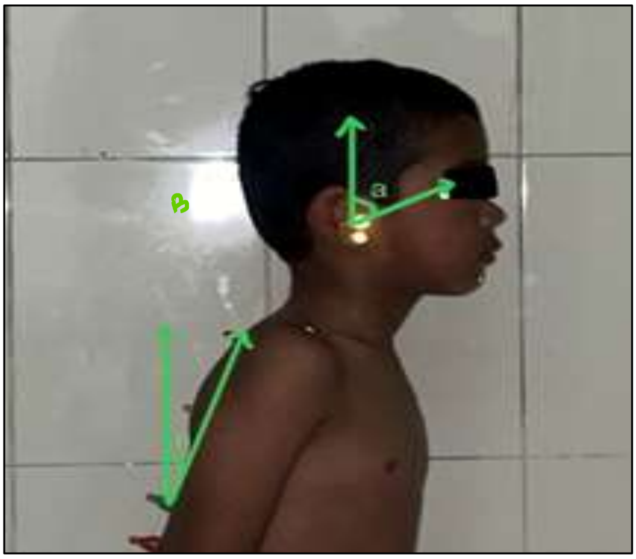

Figure 1: (a and b): Head angle and thoracic inclination.

Neck angle: The angle is drawn from tragus to C7 with regard to vertical.[10]

Trunk angle: This angle is set up by line attaching C7 and T12 and a line drawn from T12 to greater trochanter.

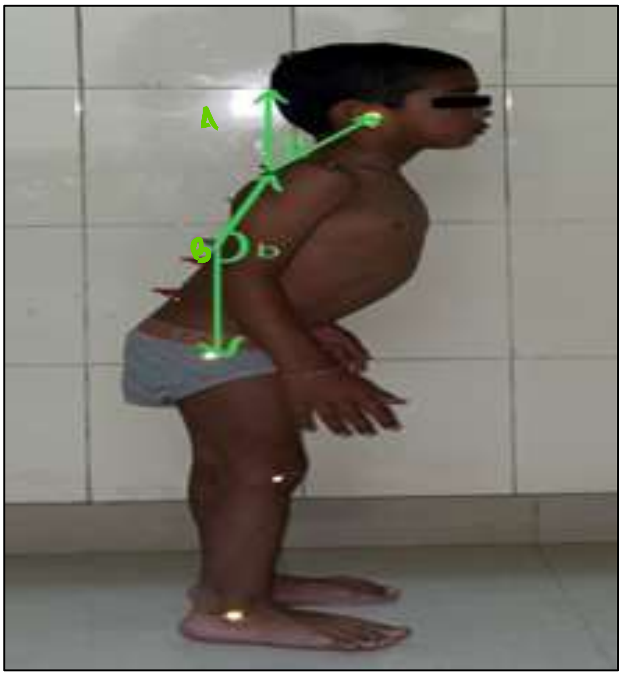

Figure 2: (a and b) Neck angle and trunk angle.

Cervico thoracic angle: It is angle between line of tragus to C7 and line of C7 to T12.[10]

Pelvic tilt: It is the line drawn from greater trochanter to ASIS with regard to vertical and is measured from vertical over intersect.[10]

Figure 3: (a and b) Cervico-thoracic angle and pelvic tilt.

Lumbar angle: A line drawn from T12 to ASIS and line drawn through ASIS to greater trochanter forms lumbar angle.[10]

Angle of ankle joint: A line drawn from knee joint line to lateral malleolus. Another line drawn from lateral malleolus to 5th metatarsal. A line is drawn perpendicular to foot line. Angle it makes with leg line is ankle angle.[17]

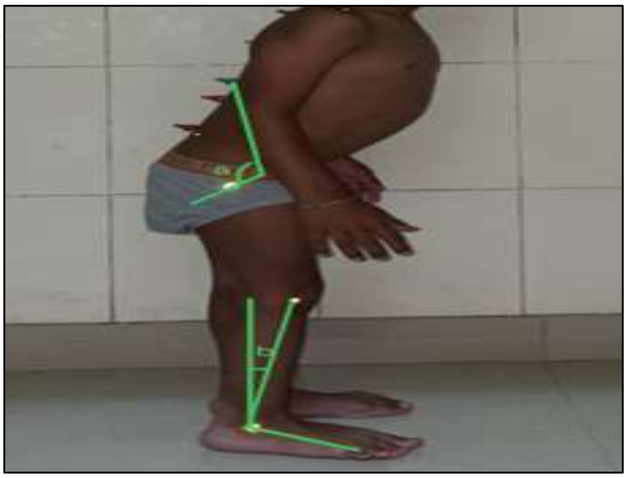

Figure 4: (a and b) Lumbar angle and angle of ankle joint.

Lumbar curve: A line drawn from T12 and L3 and the line drawn from L3 and S2 forms the lumbar curve.[10]

Angle of knee joint: A line drawn from greater trochanter to knee joint line and extended downwards. Another line is drawn from knee joint line to lateral malleolus. The angle between extended line and line parallel to leg makes knee angle.[17]

Figure 5: (a and b) Lumbar curve and angle of knee joint.

Angle of hip joint: A line drawn from greater trochanter to knee joint line and extended upward. Another line drawn parallel to trunk. Angle between these two lines make hip angle.[17]

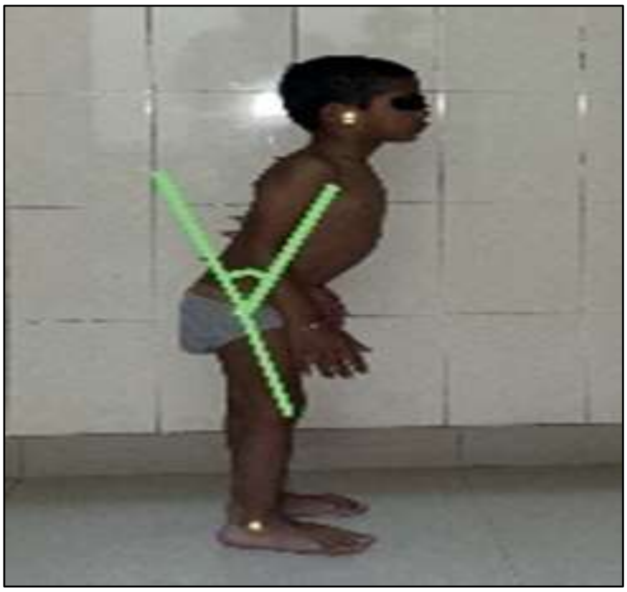

Figure 6: Angle of hip joint.

Horizontal alignment of head: Angle between two ear lobe and a horizontal line.[14]

Horizontal alignment of acromion: Angle between two acromion and a horizontal line.[14]

Horizontal alignment of ASIS: Angle between two ASIS and a horizontal line.[14]

Figure 7: (a-c) Horizontal alignment of head, horizontal alignment of acromion and horizontal alignment of ASIS.

Inclination of the head: It is the angle between glabella, menton and horizontal line.[14]

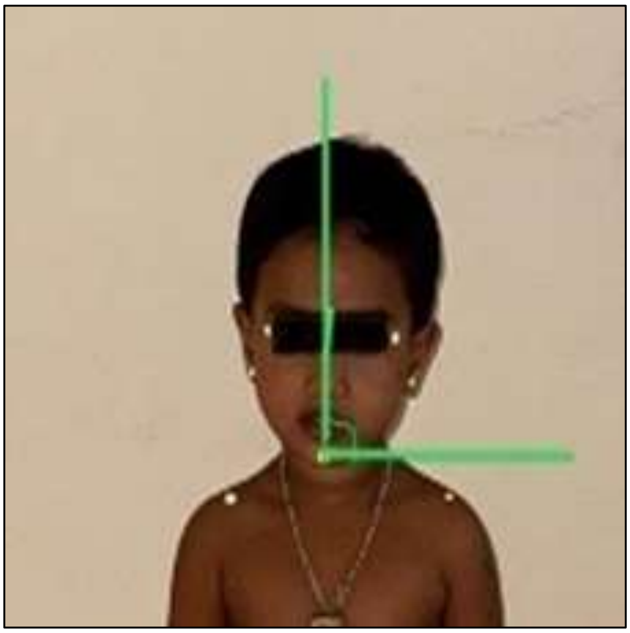

Figure 8: Inclination of the head.

Scapular alignment: It is the angle between point of intersection of the spine of the scapula and the medial margin, the inferior angle of scapula and horizontal line.[14]

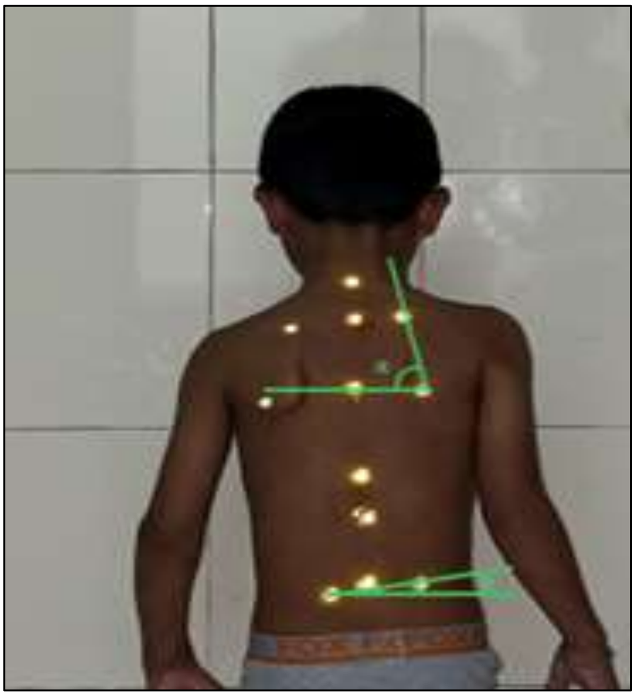

Figure 9: (a and b) Scapular alignment and horizontal alignment of PSIS.

Horizontal alignment of PSIS: The angle between two PSIS and a horizontal line.[14]

Horizontal alignment of scapula: The angle between inferior angle of scapula and a horizontal line.[14]

Figure 10: Horizontal alignment of scapula.

For postural angles extraction, a system with the following specifications was used; Intel(R) Core (TM) i5 1135G7 CPU @ 4.20 GHz, 8 GB DDR4 RAM, 64-bit Windows 10 operating system, Matlab 2022a platform. A graphical user interface (GUI) was developed in Matlab for identifying marker positions, calculating postural angles, and storing the angle values on the local server.

A manual approach was used where a biomechanist identified the positions of the markers by clicking on the center of the retro-reflective markers. The x and y coordinates of the mouse clicks were stored for each marker and fed to an automated postural angle calculation module to get the values of the postural angles. The calculated postural angles were stored automatically on the local server using a Matlab script.

Statistical analysis

The IBM SPSS 25.0 used to conduct a comparison between the patient and control groups and parameters were analyzed by t test. To determine whether the cervical, thoracic, lumbar, and pelvic angles are correlated with one another, Pearson correlation coefficients were calculated. The level of significance was fixed at $p<0.05$.

RESULTS

The 34 children in total successfully completed study, and same 34 children used to analyse data. There were seventeen children in CP group and seventeen children in TD group. With 95% confidence interval, the level of significance was maintained at 5%. Table 1 baseline characters didn't reveal any appreciable differences between groups. Baseline characters therefore uniform.

The analysis for the difference between two independent groups was done using a summary independent t-test on parameters like head angle, knee angle, pelvic tilt etc. Table 2 lists the variables for the CP and TD groups.

The two groups were found to differ in every measure but CTA, PT, AH, AK, AA, IH, HAAC, SAL, SAR, HAP and HAS were significantly different in CP group rather than control group ($p<0.05$). CTA, AH, AK, AA, HAAC, SAL, SAR and HAS found to be significantly higher in CP group ($p<0.01$) rather than in control group.

Table 3 summarizes the correlations between the trunk angle, pelvic tilt, and other spinal angles in CP group. Most of the angles were found to be correlated with other angles ($p<0.05$) but HA was found to be significantly correlated with AH ($p<0.009$) and AK ($p<0.009$). NA was found to be associated with AH ($p<0.006$).

TI had a correlation with PT ($p<0.001$) and HAHEAD ($p<0.006$) while AH was found to be associated with AK ($p<0.001$) and HAASIS ($p<0.008$).

Table 1: Baseline characteristics of children in study.

Variables	CP group (n=17), mean±SD	TD group (n=17), mean±SD	T value	P value
Gender	M=13, F=4	M=10, F=7	-1.086	0.285
Age (in years)	6.24±2.86	6.88±2.82	-0.663	0.512
Height	106.50±19.45	115.47±19.60	-1.340	0.190
Weight	18.75±10.32	22.26±8.83	-1.065	0.295
BMI	15.46±3.16	16.07±1.27	-0.738	0.466

M-Male, F-Female, age in years, Height in cm, Weight was in cm and BMI was in Kg/m^2

Table 2: Comparison of postural angles in CP group and TD group.

Parameters	CP group (n=17), mean±SD	TD group (n=17), mean±SD	T test	P value
HA	72.34±14.06	70.79±10.03	0.37	0.714
NA	34.79±11.54	33.83±4.53	0.319	0.752
CTA	161.76±10.81	151.85±7.81	3.063	0.004**
TA	152.70±6.61	154.81±9.08	-0.772	0.446
TI	24.18±40.48	6.18±4.60	1.821	0.078
PT	35.48±9.70	29.27±7.91	2.043	0.049*
LC	162.77±13.21	165.01±9.72	0.563	0.577
LA	113.12±11.52	112.18±9.36	0.262	0.795
AH	19.86±9.49	3.11±2.68	6.998	0.000**
AK	27.04±12.02	7.82±4.05	6.247	0.000**
AA	15.91±5.13	7.49±3.20	5.735	0.00**
IH	87.79±4.24	91.22±4.08	-2.4	0.022*
HAHEAD	3.30±2.18	2.71±1.43	0.931	0.359
HAAC	3.50±1.61	1.37±0.96	4.658	0.000**
HAASIS	4.61±3.39	2.88±2.64	1.659	0.107
SAL	91.63±6.40	80.98±5.12	5.355	0.000**
SAR	94.46±6.89	84.11±5.12	4.965	0.000**
HAP	4.87±2.86	2.98±2.00	2.224	0.033*
HAS	5.55±4.62	2.19±1.54	2.837	0.008**

HA-Head angle; NA-Neck angle; CTA-Cervico-thoracic angle; TA-Trunk angle; TI-Thoracic inclination; PT-Pelvic tilt; LC-Lumbar curve; LA-Lumbar angle; AH-Angle of hip joint; AK-Angle of knee joint, AA-Angle of ankle joint, IH-Inclination of the head; HAHEAD-Horizontal alignment of the head; HAAC-Horizontal alignment of the acromion; HAASIS-Horizontal alignment of the ASISs; SAL-Scapular alignment left; SAR-Scapular alignment right; HAP-Horizontal alignment of the PSIS; HAS-Horizontal alignment of the scapula.

Table 3: Correlation of postural angles in CP group.

Variables		HA	NA	CTA	TA	TI	PT	LC	LA	AH	AK	AA	IH	HAHEAD	HAAC	HAASIS	SAL	SAR	HAP	HAS
HA	r	1	0.557*	-0.542*	-0.452	-0.100	0.196	-0.207	-0.313	0.613**	0.609**	0.299	0.351	-0.093	-0.016	0.511*	0.251	-0.123	0.111	0.247
	P		0.020	0.025	0.069	0.703	0.452	0.425	0.222	0.009	0.009	0.243	0.168	0.721	0.951	0.036	0.332	0.638	0.670	0.340
NA	r	0.55*	1	-0.572*	-0.346	-0.526*	0.386	0.093	-0.060	0.637**	0.579*	0.149	0.284	-0.401	-0.338	0.447	0.517*	0.048	0.380	0.184
	P	0.020		0.017	0.174	0.030	0.125	0.723	0.818	0.006	0.015	0.568	0.269	0.111	0.185	0.072	0.033	0.855	0.133	0.481
CTA	r	-0.54*	-0.57*	1	0.075	0.262	-0.085	0.452	0.320	0-.395	0-.398	-0.133	-0.494*	0.300	0.190	-0.078	-0.540*	0.341	-0.251	-0.272
	P	0.025	0.017		0.776	0.309	0.746	0.069	0.210	0.117	0.114	0.611	0.044	0.243	0.464	0.767	0.025	0.180	0.332	0.292
TA	r	-0.45	-0.346	0.075	1	-0.043	0.138	-0.289	0.023	-0.324	-0.449	-0.299	0.199	0.245	-0.179	-0.327	-0.009	0.026	-0.135	-0.250
	P	0.069	0.174	0.776		0.869	0.598	0.260	.929	0.205	0.070	0.243	0.443	0.342	0.491	0.200	0.972	0.922	0.606	0.333
TI	r	-0.100	-0.526*	0.262	-0.043	1	-0.739**	0.352	0.404	-0.112	-0.129	0.245	-0.302	0.641**	0.155	-0.179	-0.321	-0.043	0.041	0.287
	P	0.703	0.030	0.309	0.869		0.001	0.166	0.108	0.669	0.622	0.344	0.238	0.006	0.552	0.492	0.209	0.871	0.876	0.263
PT	r	0.196	0.386	-0.085	0.138	-0.739**	1	-0.111	-0.473	0.212	0.199	-0.001	0.381	-0.363	-0.271	0.252	0.269	0.254	-0.137	-0.396
	P	0.452	0.125	0.746	0.598	0.001		0.673	0.050	0.413	0.445	0.998	0.131	0.152	0.293	0.329	0.296	0.325	0.600	0.116
LC	r	-0.207	0.093	0.452	-0.289	0.352	-0.111	1	0.575*	-0.051	-0.130	-0.039	-0.115	0.335	-0.087	-0.120	-0.076	0.239	0.293	-0.061
	P	0.425	0.723	0.069	0.260	0.166	0.673		0.016	0.847	0.618	0.881	0.659	0.189	0.739	0.647	0.772	0.356	0.254	0.816
LA	r	-0.313	-0.060	0.320	0.023	0.404	-0.473	0.575*	1	-0199	-0.314	-0.277	-0.170	0.390	-0.044	0.008	-0.223	-0.131	0.249	0.163
	P	0.222	0.818	0.210	0.929	0.108	0.055	0.016		0.445	0.219	0.283	0.514	0.122	0.866	0.975	0.389	0.617	0.335	0.532
AH	r	0.613**	0.637**	-0.395	-0.324	-0.112	0.212	-0.051	-0.199	1	0.814**	0.379	0.180	0.031	-0.425	0.623**	0.487*	-0.100	0.264	0.371
	P	0.009	1.006	0.117	0.205	0.669	0.413	0.847	0.445		0.000	0.134	0.490	1.906	0.089	0.008	0.047	0.703	0.305	0.143
AK	r	0.609**	0.579*	-0.398	-.449	-0.129	0.199	-0.130	-0.314	0.814**	1	0.605*	0.104	-0.070	-0.529*	0.528*	0.386	0.211	-0.030	0.316
	P	0.009	0.015	0.114	0.070	0.622	0.445	0.618	0.219	0.000		0.010	0.691	0.791	0.029	0.029	0.126	0.415	0.909	0.217
AA	r	0.299	0.149	-0.133	-0.299	0.245	-0.001	-0.039	-0.277	0.379	0.605*	1	-0.340	-0.124	-0.067	0.260	-0.029	0.462	-0.230	0.539*
	P	0.243	0.568	0.611	0.243	0.344	0.998	0.881	0.283	0.134	0.010		0.182	0.634	0.799	0.314	0.911	0.062	0.375	0.026
IH	r	0.351	0.284	-0.494*	0.199	-0.302	0.381	-0.115	-0.170	0.180	0.104	-0.340	1	0.292	-0.506*	-0.109	0.511*	-0.225	0.106	-0.134
	P	0.168	0.269	0.044	0.443	0.238	0.131	0.659	0.514	0.490	0.691	0.182		0.255	0.038	0.677	0.036	0.385	0.687	0.608
HAHEAD	R	-0.09	-0.401	0.300	0.245	0.641**	-0.363	0.335	0.390	0.031	-0.070	-0.124	0.292	1	-0.355	-0.193	-0.153	-0.109	0.053	0.032
	P	0.721	0.111	0.243	0.342	0.006	0.152	0.189	0.122	0.906	0.791	0.634	0.255		0.163	0.457	0.556	0.678	0.840	0.904
HAAC	r	-0.01	-0.338	0.190	-0.179	0.155	-0.271	-0.087	-0.044	-0.425	-0.529*	-0.067	-0.506*	-0.355	1	-0.139	-0.465	-0.276	0.001	0.022
	P	0.951	0.185	0.464	0.491	0.552	0.293	0.739	0.866	0.089	0.029	0.799	.038	0.163		0.595	0.060	0.283	0.997	0.935
HAASIS	r	0.51*	0.447	-0.078	-0.327	-0.179	0.252	-0.120	0.008	0.623**	0.528*	0.260	-0.109	-0.193	-0.139	1	0.073	-0.005	0.011	0.216
	P	0.036	0.072	0.767	0.200	0.492	0.329	.0647	0.975	0.008	0.029	0.314	0.677	0.457	0.595		0.781	0.984	0.965	0.405
SAL	r	0.251	0.517*	-0.540*	-0.009	-0.321	0.269	-0.076	-0.223	0.487*	0.386	-0.029	0.511*	-0.153	-0.465	0.073	1	0.056	-0.034	0.091
	P	0.332	0.033	0.025	0.972	0.209	0.296	0.772	0.389	0.047	0.126	0.911	0.036	0.556	0.060	0.781		0.831	0.898	0.729
SAR	r	-0.12	0.048	0.341	0.026	-0.043	0.254	0.239	-0.131	-0.100	0.211	0.462	-0.225	-0.109	-0.276	-0.005	0.056	1	-0.526*	-0.134
	P	0.638	0.855	0.180	0.922	0.871	0.325	0.356	0.617	0.703	0.415	0.062	0.385	0.678	0.283	0.984	0.831		0.030	0.607
HAP	r	.111	0.380	-0.251	-0.135	0.041	-0.137	0.293	0.249	0.264	-0.030	-0.230	0.106	0.053	0.001	0.011	-0.034	-0.526*	1	0.276
	P	0.670	0.133	0.332	0.606	0.876	0.600	0.254	0.335	0.305	0.909	0.375	0.687	0.840	0.997	0.965	0.898	0.030		0.284
HAS	r	0.247	0.184	-0.272	-0.250	0.287	-0.396	-0.061	0.163	0.371	0.316	0.539*	-0.134	0.032	0.022	0.216	0.091	-0.134	0.276	1
	P	0.340	0.481	0.292	0.333	0.263	0.116	0.816	0.532	0.143	0.217	0.026	0.608	0.904	0.935	0.405	0.729	0.607	0.284	

HA-Head angle; NA-Neck angle; CTA-Cervico-thoracic angle; TA-Trunk angle; TI-Thoracic inclination; PT-Pelvic tilt; LC- Lumbar curve; LA-Lumbar angle; AH-Angle of hip joint; AK-Angle of knee joint, AA-Angle of ankle joint, IH-Inclination of the head; HAHEAD-Horizontal alignment of the head; HAAC-Horizontal alignment of the acromion; HAASIS-Horizontal alignment of the ASISs; SAL-Scapular alignment left; SAR-Scapular alignment right; HAP-Horizontal alignment of the PSIS; HAS-Horizontal alignment of the scapula

DISCUSSION

CP is a group of chronic mobility and postural abnormalities that limit activities and are thought to be caused by non-progressive disturbances in the developing foetal or infant brain. In CP, spinal abnormalities result from an imbalance between the muscle and postural forces acting on the developing axial skeleton.[16] An effective, economical, quick, and non-invasive way to evaluate posture is through photographic analysis. The primary purpose of this study was to evaluate the posture of children with spastic CP and compare their postural angles with healthy children.

The results demonstrate a significant difference between various angles of two groups. Postural angles in children with CP were altered from the postural angles of children with TD. In CP group, there was decrement of angles like TA, IH and LC while increment of angles like HA, NA, CTA, TI, PT, LA, AH, AK, AA, HAHEAD, HAAC, HAASIS, SAL, SAR, HAP, HAS. Deceuninck et al observed comparable findings, i.e., substantial alterations in the positional parameters of the pelvis of ambulatory adolescents with CP. They did radiographic examination of lumbar-pelvic-femoral complex in ambulatory adolescent with CP and compared these data with asymptomatic population.[17] However, only few angles like pelvic incidence, pelvic tilt and sacral slope, lumbar lordosis and thoracic kyphosis, C7 plumb line and pelvic-femoral angle were calculated in that previous study. To our knowledge, this study is pioneer work in which angles from every view (anterior, posterior, lateral) have been calculated. As a result, it was challenging to compare the current findings to those in the literature because the majority of these investigations either used healthy children and adolescents or limited angles were calculated in CP population.[4,9,13,19]

This study also found a significant relationship among postural angles in CP group. Pelvic movement is frequently absent in children with CP and movement resistance is generally higher. Patients with ambulant CP typically have an anterior imbalance when standing. Additionally, aberrant pelvic orientation and hip flexion contractures may be associated with and contribute to development of sagittal abnormalities brought on by abnormal forces acting on lumbar spine and pelvis resulting in correlation of thoracic inclination and pelvic tilt. Reduced hip extension and pelvic tilt alterations may be caused by weak hip extensors, abductors, and abdominal muscles which in turn can affect relationship between lumbar angle and pelvic tilt. When there are primary deviations at trunk and pelvis/when there are secondary deviations brought on by limb pathology, angle of hip, knee and ankle in the CP group increases.[18] Our research is in line with that of Suh et al who radiographically analysed sagittal spinal alignment in children with CP and discovered significant relationships between sagittal spinopelvic parameters (sacral slope, pelvic tilt, pelvic incidence, S1 overhang, thoracic kyphosis, thoracolumbar kyphosis, and lumbar lordosis). This study also found a significant difference in sagittal spinopelvic parameters between CP and normal control groups, indicating that pelvic orientation affects gross body alignment and that spinal alignment functions as compensatory mechanism to maintain gross sagittal balance.[20] Photographic postural analysis (craniovertebral angle, sagittal head tilt, sagittal shoulder-C7 angle, thoracic kyphosis angle, coronal head tilt, coronal shoulder, coronal pelvic angle) was performed on children with diparetic and hemiparetic CP by Erbay et al. They discovered significant difference in lumbar lordosis angle between 2 groups those with diparesis had larger lumbar lordosis angle than those with hemiparesis. One could argue that children in this condition need to adjust their body mechanics more than children with diparetic CP do in order to compensate for their afflicted sides.[8]

For researchers and physicians, having valid and trustworthy assessment methods that are simple to use, affordable, non-invasive, and without side effects is essential. Gold standard for determining seated posture is radiography, thus researchers explore for alternate ways to study posture in recent literature. Postural issues are more prevalent during developing phases, can be uncomfortable, and can also lower quality of life by leading to musculoskeletal issues. Postural surveys are therefore quite important and affordable and straight forward approach of posture analysis is photography.

Limitations

The limitations of this study are that this study was done only on 34 subjects. Future research with a bigger sample size could examine the posture analysis in CP with various GMFCS levels and CP children.

CONCLUSION

Results of the current study demonstrated significant differences between postural angles in CP and TD group and significant correlation of postural angles in CP group. Hence, they should be measured at frequent intervals and photography method seems to be the cheapest and easily applicable method. While examining the cases of CP, muscle length, strength, and other lower extremity biomechanics that may have an impact on postural angles should be thoroughly evaluated. Clinical rehabilitation practitioners will be guided by the results of such investigations. It will be crucial clinically to measure posture regularly and to give rehabilitation experts advice on prevention and the right kind of intervention as we learn more about the children's motor skills.

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