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Anatomy

CORMIC INDEX PROFILE AND ITS CORRELATION WITH ANTHROPOMETRIC VARIABLES LIKE STATURE, SITTING HEIGHT, LOWER LIMB LENGTH AND THIGH LENGTH AMONG TRIBAL SICKLE CELL DISEASE PATIENTS IN JAGDALPUR, BASTAR,CHHATTISGARH

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ABSTRACT Sickle cell disease which is known to have negative effect on linear growth this would affect the proportional growth as well, therefore studying the Cormic Index profile in Tribal population.

This is an observational case control study of 276 subjects, aged 5yrs to 30yrs to determine the Cormic Index among tribal sickle cell disease patients of Bastar division of Chhattisgarh, India and correlation of Cormic Index with anthropomertric variables like Stature, Sitting height, Lower limb length and Thigh length. The overall mean Cormic Index of male cases(MP) and controls(MN); female cases(FP) and controls (FN)of different age groups were similar respectively. On comparison of cases with controls of subjects in the age groups among males and females, it was found to be statistically non significant. The correlation analysis was statistically significant showing moderately high inverse correlation of Cormic Index with lower limb length and thigh length in male cases; inverse correlation with Stature, moderately significant inverse correlation with stature in male cases among 5+ to 14+ yrs and in both cases and controls among females 20+ to 30 yrs age group and moderately high positive correlation with Sitting height in 15+ to 20+ yrs & 20+ to 30yrs age group. We conclude that the correlation between the Cormic Index and anthropometric variables were found to be significant in both cases and controls, a pattern was seen in males.

KEYWORDS : Cormic Index, Sickle Cell Disease, Anthropometry, Tribal Population

INTRODUCTION

It has been shown that children with sickle cell disease have poor growth[1,2]. Anthropometry is the principal method of assessing growth and height for age, it is the most useful linear measurement that gives an indication of past nutrition[3]. The Cormic Index (CI) is a ratio of sitting height to stature. It is the most common bi-variate index of shape. It is a measure of the relative length of the trunk and lower limb and it varies between individuals and groups[4,5]. There are racial or ethnic variations in the mean cormic index[6]. Africans have proportionally longer legs with CI around 52%. Asians and far Eastern populations have proportionally shorter legs with CI of 53-54%[7]. Australian Aborigines who have relatively long legs exhibited low mean CI ratio of 0.48±0.02(48%) ranging from 0.41-0.54(41-54%)[8]. Cormic Index declines throughout childhood because leg length increases faster than trunk length during prepubertal growth [6,9].Studies showed that rapid growth of the lower extremities is the characteristic of the early part of the adolescent growth spurt in stature, while growth in the sitting height component of height occurs later, subsequently growth in leg length terminates earlier than growth in sitting height or trunk length, which continues into late adolescence[10,11,12]. Thus, because the adolescent growth spurt is made up disproportionately of growth in the trunk, it produces a rise in Cormic Index in later adolescence [6,9,13,14]. Certain studies have shown a sharp change in the Cormic Index with onset of the adolescent growth spurt[6,14]. There is negative effect of the sickle cell anemia on the spinal growth and hence, Cormic Index would therefore be expected to be more obvious in the older children during the period of expected rapid growth. Shorter spinal length relative to the height increases the Cormic Index[15].

METHODS

The study was approved by Institutional Ethics Committee of Pt. Jawaharlal Nehru Medical College, Raipur (Chhattisgarh). This Observational Case-Control Study study was conducted in 276 (138 Sickling & 138 Non-Sickling) tribal individuals aged 05 to 30years belonging to Bastar division (Chhattisgarh). The sample size was calculated using 95% confidence interval anticipated and absolute precision of 0.10.The subjects were recruited over a period of sixteen months from May 2014 to September 2015. Registered cases with positive sickle solubility test or electrophoresis test for sickling were recruited for study from L.B.R.K.M Govt. Medical College, Jagdalpur and M.P.M Hospital, Jagdalpur. Matched samples for age and sex were recruited as non–sickling individuals following negative sickle solubility test from villages near Jagdalpur. Written informed consent was obtained from the parents or guardians (minor's) of all subjects in their own language. The exclusion criteria were refusal of consent, non-domicile and non-tribal population of Bastar division, Chhattisgarh.

Examination of the subject with special mention of date, time and place was done. Using standard techniques and instruments the following parameters were measured.[16,17,18]

1.Stature / Standing Height

It was measured bare footed on level ground using anthropometer .

2.Sitting Height (SH)

The subject sits erect on a stool with the head in the Frankfort plane and gentle upward pressure was exerted in the mastoid region. The shoulders and upper limb was relaxed as the hand rests on the thigh. The anthropometer was held vertically in contact with the interscapular region and back of the sacral region.

3.Lower Limb Length (LLL) / subischial leg length

This parameter was obtained indirectly for each subject by subtracting the sitting height from his/her stature.

4.Thigh Length (TL)

The subject was made to sit straight on the stool with the right knee bent at 90^{o} angles. The blades of the sliding caliper were positioned against the distal end of the femur on either side of the patella as if one were to measure its breadth. The horizontal bar of the caliper was touching the anterior surface of the thigh, proximal to the patella. Using the superior edge of the horizontal bar of the caliper as a guide, a line was marked on the anterior surface of the thigh. The measurement was taken from midpoint of inguinal crease to the mark along the midline of the thigh using a measuring tape. The Cormic Index was calculated as

(Sitting height /height) × 100.

To prevent potential sources of bias a strict protocol and criteria for measuring different variables was followed. The Pearson correlation coefficient (r) analysis was used to measure the strength of the relationship between Cormic index and anthropometric variables. The data was statistically analyzed using SPSS 16. A p value of <0.05 (two tailed) was considered as significant.

RESULTS

A total of 276 (138 Sickling & 138 Non-Sickling) tribal individuals aged 05 to 30years, were stratified in three groups according to age: (a)05 to 14+yrs (b) 15 to 19+yrs (c) 20 to 30+yrs

TableI: Mean Cormic Index Distribution Of Study Subjects According To Age Group In Tribal Males And Females

		CormicIndex(Mean±S.D)			
AgeGroup.	N	Mean	Std.Deviation	T-test (Unpaired)	P-value
05+to14+yrs(MP)	12	51.1649	2.66624	1.723614	0.098
05+to14+yrs(MN)	13	49.7553	1.21773		
15+to19+yrs(MP)	17	49.9325	1.34341	-0.1871	0.852763
15+to19+yrs(MN)	17	50.0345	1.80395		
20+to30+yrs(MP)	39	50.0069	1.80676	-1.32662	0.188556
20+to30+yrs(MN)	40	50.5197	1.62633		
05+to14+yrs(FP)	10	51.1427	1.31144	-1.06775	0.299011
05+to14+yrs(FN)	11	51.7902	1.45337		
15+to19+yrs(FP)	21	50.31	1.83708	-1.137	0.261488
15+to19+yrs(FN)	19	50.9233	1.53146		
20+to30+yrs(FP)	39	50.309	1.68246	-1.3079	0.194902
20+to30+yrs(FN)	38	50.8187	1.73768		

Note: Male Cases(MP) And Controls(MN); Female Cases(FP) And Controls (FN)

Student's t-test was done to determine any significant difference between the mean values of CI in the age groups among males and females and it was found to be non significant

Table II. Pearson's Correlation Coefficient (r) of CI (X) with anthropometric variables(Y) among males.

MALES	Stature(cm)(Y)		SH(Y)		LLL(Y)		TL(Y)	
	Mean ±SD	r (P-value)	Mean ±SD	r (P-value)	Mean±SD	r (P-value)	Mean±SD	r (P-value)
Case (n=12)	122.78±18.66	r=-0.578* (P=0.049)	62.56±08.02	r=-0.308 (P=0.331)	60.22±11.27	r=-0.738** (P=0.006)	29.00±05.87	r=-0.738** (P=0.006)
Control(n=13)	142.49±17.35	r=-0.302 (P=0.316)	70.84±08.35	r=-0.100 (P=0.746)	71.65±09.35	r=-0.472 (P=0.104)	34.63±05.29	r=-0.232 (P=0.445)
case(n=17)	162.38±07.79	r=-0.409 (P=0.103)	81.04±03.60	r=0.154 (P=0.556)	81.34±05.16	r=-0.725** (P=0.001)	40.85±02.91	r=-0.627** (P=0.007)
Control(n=17)	161.59±07.16	r=0.315 (P=0.218)	80.89±05.31	r=0.759** (P=0.001)	80.70±03.78	r=-0.469 (P=0.057)	39.42±02.51	r= 0.157 (P=0.547)
Case (n=39)	163.03±05.82	r=-0.010 (P=0.951)	81.53±04.10	r=0.707** (P=0.001)	81.51±04.15	r=-0.713** (P=0.001)	40.37±02.76	r=-0.248 (P=0.128)
Control(n=40)	165.53±06.66	r=-0.122 (P=0.455)	83.61±04.06	r=0.563** (P=0.001)	81.92±04.49	r=-0.688** (P=0.001)	40.45±02.84	r=-0.357* (P=0.024)

(Note: * Shows Strong Correlation (at P- 0.05) ,**very Strong Correlation (at P- 0.01)

Results in males with age group 05+ to 14+ yrs shows CI has moderate negative correlation values with variable stature as r = -0.578* (P = 0.049) and also shows moderately high negative correlations with LLL and TL at r = -0.738** (P = 0.006), & r = -0.738**(P = 0.006) respectively in cases.

While males with 15+ to 19+ age group shows CI having moderately high negative correlation values with LLL and TL at r = - 0.725** (P = 0.001) & r = -0.627** (P = 0.007) respectively in cases and moderately high positive correlation with SH in controls at r = 0.759**(P = 0.001).

For males with age group 20+ to 30+, the CI shows moderately high positive correlations with SH at r = 0.707** (P = 0.001) while moderate correlation value with r = 0.563** (P=0.001) in both cases & control respectively ,also showing moderately high negative correlations with LLL at r= -0.713** (P = 0.001), r= -0.688** (P = 0.001) in both cases & control respectively and showing very strong significance at (P = 0.001) for each value. However it shows low negative correlation for TL in controls at r= -0.357*(P = 0.024).

Table III. Pearson's Correlation Coefficient (r) of CI (X) with anthropometric variables(Y) among females.

FEMALES	Stature(cm)(Y)		SH(Y)		LLL(Y)		TL(Y)	
	mean±SD	r (P-value)	Mean ±SD	r (P-value)	mean±SD	r (P-value)	mean ±SD	r (P-value)
Case (n=10)	133.59±15.69	r=-0.440 (P=0.203)	68.24±07.51	r=-0.245 (P=0.495)	65.35±08.49	r=-0.596 (P=0.069)	32.89±04.72	r=-0.340 (P=0.337)
Control (n=11)	139.29±16.60	r=-0.468 (P=0.147)	72.04±07.94	r=-0.271 (P=0.421)	67.25±09.00	r=-0.624* (P=0.040)	33.85±04.49	r=-0.544 (P=0.337)
Case (n=21)	151.74±06.55	r=-0.116 (P=0.615)	76.33±04.04	r=0.604** (P=0.004)	75.41±04.59	r=-0.698** (P=0.001)	37.84±02.52	r=-0.065 (P=0.781)
Control (n=19)	150.56±05.18	r=-0.008 (P=0.974)	76.67±03.45	r=0.649** (P=0.003)	73.89±03.43	r=-0.665** (P=0.002)	36.77±02.21	r=-0.188 (P=0.441)
Case (n=39)	151.42±07.00	r=-0.401* (P=0.011)	76.13±03.41	r=0.346* (P=0.031)	75.29±05.12	r=-0.778** (P=0.001)	36.28±02.87	r=-0.298 (P=0.065)
Control (n=38)	151.91±05.19	r=-0.558** (P=0.001)	77.15±02.47	r=0.465** (P=0.003)	74.76±04.57	r=-0.885** (P=0.001)	36.33±02.27	r=-0.336* (P=0.039)

(Note : * shows strong correlation (at p- 0.05) ,**very strong correlation (at p- 0.01)

The results of correlation analysis in females 05+ to 14+age group shows that the CI has moderately high negative correlation with LLL at r = -0.624* (P = 0.040)

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The correlation analysis in females 15+ to 19+age group shows that the CI has moderately high positive correlations with SH at r = 0.604** (P= 0.004) & r = 0.649** (P= 0.003) in both cases & control , moderately high negative correlations with LLL at r= -0.698** (P=0.001)& r= -0.665** (P = 0.002) in both cases & control with very strong significance (P= 0.001 <P=0.01). The correlation analysis in females 20+ to 30 age group shows that the CI has moderate negative correlations with stature at r = -0.401* (P= 0.011 < P= 0.05), r=-0.558* (P=0.001) respectively in both cases & control ; it shows low positive correlations with SH at r = 0.346* (P= 0.031 < P= 0.05 ,) & moderate r = 0.465** (P= 0.003<P=0.01) respectively in both cases & control and shows moderately high negative correlations with LLL at r= -0.778** (P=0.001), in cases while we found high negative correlation at r=

-0.885** (P=0.001) in controls and low negative correlation with TL at r = -0.336* (P= 0.039) in control group .

DISCUSSION

The mean CI decreased with increasing age group in females but not so in males (Table I), studies by Akodu et al[15] showed that the mean CI decreased with age irrespective of gender and haemoglobin genotype.

CI has inverse relationship with stature as it occupies the denominator in the formulae. This is purely an arithmetical relationship. As stature increases CI decreases and vise versa.

In the tribal males 5+ to 14+ age group the mean CI is less in control at 49.75±01.22. This implies that they might have longer lower limbs, which is the physiological growth pattern[6,9-14]. The cases should have similar results if not suffering from SCD. The cases having higher mean CI at 51.16± 02.67 suggests that the LLL contribution is less in these subjects, implies that lower limb growth is affected, could be due to SCD or malnutrition. Also Pearson's correlation analysis (Table II) shows moderately high inverse relation between CI and LLL in male cases <20yrs.

Beutler E [19]suggested thatthe hypoxia in normal tissue due to sickle shaped RBC hampers the normal growth and development. Malnutrition in SCD children and adolescents may be due to innumerable factors was suggested by dos Santos et al[20], such as the low consumption of food during the pain crisis (also suggested by Mukheerjee Malay B[21]) or increased metabolism due to increased red blood cells turnover due to hyper hemolysis or the severity of the disease.

There are studies which show occurrence of avascular necrosis of long bones in SCD. Cortical infarction of the diaphyses of the long bones which is a well-documented complication of sickle cell anemia in children leading to radiographic changes has been described by many studies[22,23]. Hernigou et al[24] (1991) recorded a 32.5% incidence of femoral head involvement SCD. Omojola, M.F. *et al*[25] .(1993)., also found spinal change and avascular necrosis of femoral head was common.

The results (Table II) of mean CI in males with 15+ to 19+ yrs age group in cases was 49.93±01.80 which is less than controls in the same age group at 50.03±01.80 ,studies have shown that there is relatively faster increase in the sitting height in late adolescence age [4,6,9-14,26,27]

In control groups as their SH increases with age the CI value also increases .The mean value of CI in15+ to 19+ yrs age group at 50.03±01.80 in controls is higher than the mean value of CI in 5+ to 14+yrs age group at 49.75 ± 01.22. In the cases of this group the CI is less could be because the SH is not increasing most probably due to SCD. Similar findings of significantly lower mean value among females with sickle cell anaemia older than 10 years was found by Akodu SO *et al*[15] in their study translating to relatively shorter trunks which they explained by possible narrowing of intervertebral discs as a result of repeated vasoocclusion [26-29].

Also on Pearson's correlation analysis the SH is showing moderately high positive correlation in both males and females in late adolescents and adults except in children <15yrs .As SH (trunk) increases in late adolescence phase contributing to stature[4, 6,9-14,26,27] ..

This also explains the findings in <15yrs age group in both males and females were inverse correlation is seen (not significant) as contribution to stature is less by SH than LLL in early adolescence.

In the males, age group of 20+ to 30 yrs the results of mean CI are similar in both group 50.01±01.81 & 50.52±01.63 in cases and control respectively which is consistent with studies done by Ashcroft M. T *et al* [27]that showed that the SCD patients caught up with their peers as they grow.

The mean Cormic Index in the age groups among males and females has statistically non significant difference on t-test.

Correlation between CI and TL: The Thigh length is the subcomponent of stature in the denominator of CI formulae so it should have inverse correlation as seen in this study also, (r) is showing moderately high significance in male cases among 5+ to 14+ yrs age group and 15+ to 19+ yrs age group could be explained by severity of SCD. There are no studies comparing the CI to TL in SCD subjects.

In the female groups (Table III) correlation analysis showed statistically significant findings in both cases and controls but no pattern was found. Further studies with larger sample size are suggested.Some studies suggest that the proportions of leg and trunk length can be affected by socio-economic status and growth in childhood[30,31]. The leg length may be a useful marker of early childhood conditions when studying the impact of early life deprivation on adult disease risk[32-34].

CONCLUSIONS

The correlation between the Cormic index and anthropometric variables were found to be significant in both cases and controls, a pattern was seen in males. The findings of this study may help to take steps in improving anthropometric growth parameters in children suffering from sickle cell disease as well as socio economic status of tribal people, which could further improve the clinical outcome and prognosis of tribal's affected by sickle cell disease.

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