

## Developmental Anomalies of Vertebral Column: A Comparative Osteological Study between Coastal Odisha and Western Odisha Population.

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**Abstract** Aim: To Study And Compare Different Types Of Vertebral Anomalies Between Two Socioeconomically And Culturally Different Populations Of Odisha.

Background: Vertebral Anomalies Are Multifactorial In Origin. Factors Responsible For Development Of Vertebral Abnormalities Are Alcohol, Retinoic Acid And Oral Contraceptive Pills. The Teratogenic Effect Of These Factors On Vertebral Development Has Been Studied By Many Authors. Deficiency Of Folic Acid Is One Of The Leading Causes Of Neural Tube Defect. There Are Genes Controlling The Development Of Vertebra And Failure Of Expression Of These Genes Lead To Vertebral Anomalies. Our Study Is An Attempt To Compare The Incidence Of Vertebral Anomalies Between Two Socioeconomically And Culturally Different Population And Find Out Possible Factors Responsible For The Difference.

Methods: We Collected All The Vertebrae Preserved In The Anatomy Department Of S.C.B. Medical College, Cuttack And V.S.S. Institute Of Medical Science And Research (Vimsar, Burla). Cuttack Is Situated In Coastal Odisha And Burla Belongs To Western Odisha. The Natives Of Western Odisha Constitute High Proportion Of Tribals Who Are Socioeconomically And Culturally Backward To Coastal Odisha Population. We Excluded Vertebrae With Incomplete Ossification And Vertebrae Showing Gross Pathological Changes. We Studied The Congenital Defects Like Block Vertebrae, Sacralisation And Spina Bifida. We Compared The Incidence Of Both The Samples And Made A Statistical Analysis To Know Whether The Difference Is Statistically Significant.

Result: The Incidence Of Congenital Vertebral Defects Was High In The Vertebrae Of Western Odisha Population. The Difference Was Statistically Significant (P Value-0.05).

Conclusion: Regular Consumption Of Country Liquor Which Is A Usual Practice Among Tribal Women Could Be A Cause Of High Incidence Of Block Vertebrae And Sacralisation. Dietary Deficiency Of Folic Acid Might Be Responsible For High Incidence Of Spina Bifida. To Rule Out Some Genetic Association A Genetic Study Of This Population Will Be Helpful.

**Keywords:** Vertebral Anomalies, Block Vertebrae, Sacralisation, Spina Bifida.

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### I. Introduction

The Vertebral Column Develops From The Sclerotomes Of The Somites. The Caudal And Cranial Halves Of Adjacent Sclerotomes Fuse To Form Each Vertebra. The Process Of Formation And Rearrangement Of Segmental Sclerotome Is Complicated. So It Is Possible To Have Anomalies Like Unsegmented Vertebrae Due To Defective Segmentation Of Somites Or Spina Bifida Due To Defective Fusion Of Vertebral Arches. Sacralisation Of 5th Lumbar Vertebra Also Occurs Due To Non Segmentation Of Sclerotome. Alcohol, Retinoic Acid, Oral Contraceptive Pills Are Some Important Teratogens Which Are Responsible For Vertebral Abnormalities<sup>1</sup>. Studies Show That 50% Of Fetal Alcohol Syndrome Patients Present With Congenital Fusion Of Cervical Vertebrae On Radiographs Of The Neck<sup>2</sup>. Folic Acid Deficiency Leads To Severe Form Of Vertebral Arch Defect Like Spina Bifida. S.C.B. Medical College, Cuttack Is Situated In Coastal Odisha Where Literacy Rate And Socioeconomic Condition Of Local Inhabitants Is Higher Than Western Odisha, Where Vimsar, Burla Is Situated. The Natives Of Western Odisha Constitute Higher Proportion Of Tribals Who Are Habitual Drinkers Of Country Liquor And Their Access To Health Care Facility Is Also Poor. We Therefore Undertook This Study To Search For Incidence Of These Congenital Defects In The Dried Vertebrae Prepared

And Collected In Anatomy Departments Of S.C.B. Medical College, Cuttack And V.S.S. Institute Of Medical Science And Research (Vimsar), Burla. Our Study Is An Endeavor To Find Out Whether The Cultural And Socioeconomic Difference Between The Two Communities Affects The Development Of Vertebral Column.

The Etiology Of Vertebral Synostosis May Be Congenital Or Acquired. The Congenital Vertebral Synostosis Is Due To Partial Or Complete Non Segmentation Of Vertebrae At The Time Of Organogenesis. But Acquired Fusion Of Vertebrae Is Usually Secondary To Diseases Like Juvenile Rheumatoid Arthritis, Tuberculosis, Ankylosing Spondylitis Or Diffuse Idiopathic Skeletal Hyperostosis. So It Is Important For Our Study To Differentiate The Congenital From Acquired Block Vertebrae. Congenital Block Vertebrae Are Characterized By Absence Of Intervertebral Disc, Maintenance Of Vertebral Body Height And Smooth Intervertebral Foramen Whereas Acquired Fusion Is Evidenced By Appearance Of Degenerative Changes In Them<sup>3</sup>. We Therefore Took Enough Care To Include Only The Congenitally Fused Vertebrae After Careful Examination Of The Differentiating Features.

## II. Materials And Method

We Collected All The Vertebrae Preserved In The Anatomy Department Of S.C.B. Medical College, Cuttack And Vimsar, Burla (Table-1). We Excluded All Damaged Vertebrae, Fused Vertebrae Showing Gross Degenerative Changes And Abnormal Calcification From Our Study (Fig.1). Vertebrae With Incomplete Ossification Were Also Excluded To Avoid Confusion With Congenital Defects Like Spina Bifida (Fig. 1). After Segregating The Vertebrae Region Wise, We Examined Them To Find Out Congenital Anomalies Related To Defects In Segmentation Or Fusion. Segmentation Defects Include Block Vertebrae And Sacralisation, Whereas Defects In Fusion Include Spina Bifida. In Block Vertebrae We Measured The Height Of Individual Vertebra And Total Height Of Fused Vertebrae To Differentiate Acquired From Congenital Block Vertebrae. We Calculated The Percentage Of Vertebrae Affected By Different Types Of Anomalies From Each College Separately And Made A Comparative Statistical Analysis To Find Out If There Is Any Significant Difference Between The Two Study Samples. Comparison Was Done By Using Chi Square Test. P Value <0.05 Was Considered Statistically Significant. The Statistical Calculation For 2 Proportion Z- Test Was Done Using The Statistical Package Spss.

**Table-1 (Study Sample)**

Name Of The Institute	No.Of Cervical Vertebrae	No.Of Thoracic Vertebrae	No.Of Lumbar Vertebrae	No.Of Sacral Vertebrae	Total Vertebrae	No.Of
S.C.B. Medical College, Cuttack	375	670	300	56	1401	
Vimsar, Burla	390	1100	400	15	1905	

### Observation

On Gross Examination Of Individual Vertebra, In Both The Study Samples We Observed Two Or More Vertebrae Fused Together To Form A Block Vertebra. All The Block Vertebrae From Lower Thoracic And Lumbar Region Showed Abnormal Ossification Of Ligaments Like Anterior Longitudinal Ligament, Posterior Longitudinal Ligament, Ligamentum Flavum Or Capsular Ligament Of Facet Joints Leading To Obliteration Of Joint Spaces And Fusion Of The Vertebrae. All The Cervical Block Vertebrae And Some Of The Upper Thoracic Block Vertebrae Showed Complete Fusion Of Anterior And/Or Posterior Segment Without Any Degenerative Changes Or Associated Abnormal Calcification. We Counted Their Number Region Wise In Each Group For Comparison. The Incidence Of Congenital Cervical Block Vertebrae Was More In The Sample Collected From Western Odisha Population. Thoracic Block Vertebra Incidence Was More In Coastal Odisha Sample (Table-2). Fig.2 (A) -2(D) Are Different Congenital Abnormalities Observed In The Samples Collected From S.C.B. Medical College, Cuttack. Fig.3(A)- 3(E) Are From Vimsar, Burla.

Sacralisation Of 5<sup>th</sup> Lumbar Which Also Occurs Congenitally Due To Non Segmentation Of Sclerotome Was Found More Frequently In Western Odisha Population (Table-2).

Incidence Of Spina Bifida Was Also More In Vertebral Sample Of Western Odisha Population (Table 2)

**Table-2**

	Unsegmented/ Cervical Vertebrae	Thoracic Block Vertebrae	Sacralisation Of Lumbar	5 <sup>th</sup> Lumbar Spina Bifida	Sacral Spina Bifida
S.C.B. Medical College	1/375	1/670	1/56	0/300	1/56
V.S.S. Medical College	5/390	1/1100	2/15	3/400	4/15



Fig.1- examples of fused vertebrae due to ossification of ligaments and open spine due to incomplete ossification excluded from study



Fig.2(a)- congenital cervical block vertebrae.



Fig.2(b)-congenital thoracic block vertebrae



Fig.2(c)-sacralisation of 5<sup>th</sup> lumbar vertebrae



Fig.2(d)- spina bifida with open sacral canal



Fig.3(a)- congenital cervical block vertebrae showing failure of segmentation of sclerotomes.



Fig.3 (b)- thoracic block vertebra.



Fig.3(c)- sacralisation of 5<sup>th</sup> lumbar



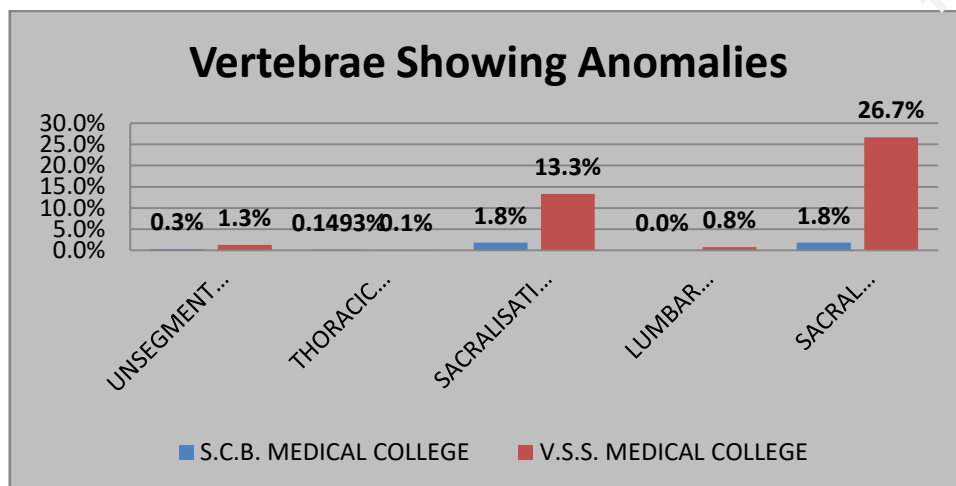
Fig.3(d)- Different grades of spina bifida affecting sacral vertebrae.



Fig.3 (e)- spina bifida affecting lumbar vertebrae.

**Statistical Analysis**

	Unsegmented/ Block Vertebrae	Cervical	Thoracic Block Vertebrae	Sacralisation Of 5 <sup>th</sup> Lumbar	Lumbar Spina Bifida	Sacral Bifida	Spina
S.C.B. Medical College	0.3%		0.1493%	1.8%	0.0%	1.8%	
Vimsar, Burla	1.3%		0.1%	13.3%	0.8%	26.7%	



The Above Table Shows The Percentage Of Anomaly In Each Of The Categories. A Statistical Test Was Done To Conclude Whether The Difference In Anomaly Is Statistically Significant To Conclude That The 2 Samples Are Different.

Null Hypothesis H<sub>0</sub>: There Is No Difference In The Sample From The 2 Colleges.

Alternative Hypothesis: There Is Difference In The 2 Samples From 2 Colleges.

Significance Level: 0.05

[DataSet1] C:\Users\saswat\Documents\Untitled2.sav

**Case Processing Summary**

	Cases				Total	
	Valid		Missing		N	Percent
College * Anomaly	N	Percent	N	Percent	3377	100.0%
	3377	100.0%	0	0.0%		

**College \* Anomaly Crosstabulation**

Count	College	Anomaly		Total
		Anomaly	Normal	
	SCB	4	1453	1457
	VSS	15	1905	1920
	Total	19	3358	3377

**Chi-Square Tests**

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.802 <sup>a</sup>	1	.051		
Continuity Correction <sup>b</sup>	2.950	1	.086		
Likelihood Ratio	4.129	1	.042		
Fisher's Exact Test				.063	.040
N of Valid Cases	3377				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.20.  
b. Computed only for a 2x2 table

The No Of Anomalies And Normal Cases In Both The Medical Colleges Were Fed Into The System. 2 Proportion Z- Test Was Done And The Significance Was Found To Be 0.05. Thus The Null Hypothesis Was Rejected And Alternative Hypothesis Was Accepted. As Per The Alternative Hypothesis It Can Be Concluded That The 2 Samples Are Statistically Different.

### III. Discussion

The Results Of Our Study Showed That Congenital Vertebral Anomalies Are More Common In Western Odisha Population Than That Of Coastal Odisha. The Difference In Incidence Of Anomalies Between The Two Communities Is Statistically Significant (P Value-0.05). Consumption Of Alcohol During Pregnancy Is One Of The Established Causative Factors Responsible For Vertebral Anomalies<sup>1,2,6</sup>. Tredwell S J In 1982 And Lowry Rb In 1977 Have Studied The Teratogenic Effect Of Alcohol. They Have Established That Maternal Consumption Of Alcohol During Pregnancy Produces Vertebral Anomalies During Embryogenesis. Tredwell Et Al Reported That 19 ( 50%) Out Of 38 Patients With Foetal Alcohol Syndrome Had Congenital Fusion Of Cervical Vertebrae On Radiographs Of The Neck. According To Strudel G. 1967 And Hall,B. 1977 Neural Crest Cells Have Got Definite Role On Secondary Segmentation Of Sclerotome. Surgical Removal Of Neural Crest Cells Impairs Secondary Segmentation Of Neural Arches Resulting In Fusion Of Vertebrae<sup>4, 5</sup>. Crest Cells Appear To Be A Particularly Vulnerable Cell Population And Are Easily Killed By Compounds Such As Alcohol<sup>1</sup>. Thus Consumption Of Alcohol In Pregnancy Disrupts The Normal Development Of Vertebrae.

The Tribal Women Of Western Odisha Are Habitual Drinkers Of Country Liquor Whereas In Other Parts Of Odisha Female Alcoholism Is Very Rare. Therefore Female Alcoholism Could Be A Factor For The High Incidence Congenital Block Vertebrae And Sacralisation Of Lumbar Vertebrae In Western Odisha Population.

Out Of All The Vertebral Anomalies Studied, The Incidence Of Spina Bifida Was Very High In Western Odisha Population. As Folic Acid Deficiency Is A Major Factor Responsible For This Defect, The High Incidence Of Spina Bifida Could Be Correlated To Dietary Deficiency Of Folic Acid In This Group. Multiple Factors Like Poverty, Illiteracy, Lack Of Awareness And Inaccessibility To Healthcare Facility Could Be Responsible For The High Incidence Spina Bifida In This Community.

The Pax-1 Gene, Which Is Expressed In All Prospective Sclerotomal Cells Of Epithelial Somites Seems To Play An Essential Role In Development Of Vertebral Column<sup>6</sup>. Failure Of Expression This Gene Could Also Be A Factor For The High Incidence Of Vertebral Anomalies, Which Needs To Be Studied To Establish Its Genetic Association.

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