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Comparative Evaluation of Craniofacial Anthropometry of Beta-Thalassemia Major Patients: A Hospital-Based Cross-Sectional Study

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ABSTRACT

Background: β-thalassemia major is associated with characteristic craniofacial deformities resulting from marrow hyperplasia. Quantitative data on these changes remain limited, particularly in Indian populations. This hospital-based cross-sectional study compared craniofacial anthropometric measurements between β-thalassemia major patients and matched healthy controls.
Methods: A total of 150 transfusion-dependent β-thalassemia major patients and 150 healthy matched controls underwent assessment of 15 soft-tissue craniofacial anthropometric measurements. Anthropometric data were analyzed, and correlations with serum ferritin were explored.
Results: The mean age at diagnosis among thalassemia patients was 9.75 ± 11.31 months; average lifetime transfusions numbered 222 ± 129. Thalassemia patients demonstrated significantly reduced facial width, total facial height, mandibular depth, nasal dimensions, mouth width, and lower third facial height, alongside increased maxillary depth and upper facial morphological height (all $p < 0.0001$). Eye length was greater, while auricular dimensions were smaller in patients. No significant correlations were found between serum ferritin levels and height or weight.
Conclusion: β-thalassemia major patients exhibit a consistent anthropometric profile of midfacial prominence, mandibular retrusion, vertical facial deficiency, nasal hypoplasia, and reduced oral/auricular dimensions. These changes reflect the pathophysiologic impact of marrow expansion and align with cephalometric literature. Early multidisciplinary evaluation is essential to address functional, aesthetic, and orthodontic implications in this population.

Keywords: Beta thalassemia major, anthropometry, craniofacial measurements, India

INTRODUCTION

Thalassemias are hereditary anaemias caused by gene alterations encoding haemoglobin alpha and beta chains. Severe β-thalassemia occurs in homozygous patients with markedly impaired β-chain production and is among the most common autosomal recessive disorders worldwide, particularly across the "thalassemia belt," which includes the parts of North and West Africa, the Mediterranean, the Indian Peninsula, the Middle East and the far Southeast Asia [1,2]. Globally, about 240 million people are carriers, with approximately 30 million in India and a mean prevalence of 3.3% [3].

Ineffective erythropoiesis in β-thalassemia triggers elevated erythropoietin (EPO) production, increasing erythroid cell output and causing bone expansion [4]. This leads to characteristic craniofacial deformities and stomatognathic alterations. Regular blood transfusions are essential to prevent cardiac failure from severe anaemia, but may cause iron overload, resulting in developmental delay, and cardiac, hepatic, and endocrine complications [5]. The severity of clinical manifestations correlates with disease form, with β-thalassemia major and intermedia producing the most pronounced signs [4]. Symptoms often appear at 4–6 months of age, including severe anaemia, growth retardation, pallor, feeding problems, recurrent fever, fractures, bleeding, infections, hepatosplenomegaly, and delayed growth [5]. Reduced bone mineral density is also reported [6].

Craniofacial characteristics include "squirrel-like," "chipmunk," or "rodent" facies, with maxillary protrusion from erythroid hyperplasia and nasal bridge depression [7–9]. Bone marrow expansion produces frontal and parietal bossing and hyperplasia of malar and maxillary bones. Other features include mandibular shortening, decreased total facial height, nasal bridge collapse, mongoloid facial structure, hypertelorism, and slanted eyes [10–13]. Dental findings include interdental spacing, forward drift of maxillary incisors, anterior open bite, maxillary protrusion, occlusal abnormalities, and delayed maxillary sinus pneumatization [14].

Craniofacial anthropometric measurements are valuable for objectively assessing skeletal and soft-tissue dimensions. In β-thalassemia major, chronic anaemia and marrow hyperplasia produce maxillary enlargement, frontal bossing, and malar prominence—changes with aesthetic, functional, and psychosocial implications. These may impair oral function, occlusion, and airway patency. Anthropometry quantitatively documents these alterations, enables monitoring over time, and facilitates comparisons with healthy populations. It also supports orthodontic, prosthetic, and surgical planning, while contributing to understanding disease effects on craniofacial growth. Comparing measurements with ideal proportions offers insight into population-specific phenotypes and medical backgrounds [15,16].

Despite the recognized prevalence of orofacial anomalies in β-thalassemia major, comprehensive data on its clinical and craniofacial manifestations remain limited in the Indian context, particularly in eastern states such as Odisha, where the condition is highly prevalent, especially in coastal districts including Cuttack, Khordha, Puri, and Jajpur. This study aimed to assess the clinical and craniofacial anthropometric measurements of paediatric and adult patients with β-thalassemia major.

MATERIALS & METHODS

Study design: Comparative cross-sectional study

Ethical approval and informed consent: The study received ethical clearance from the Institutional Ethics Committee of S.C.B. Dental College and Hospital, Cuttack, Odisha (Reference No. IEC/SCBDCH/205/2022, dated 09/08/2023), and was conducted by the ethical principles of the Declaration of Helsinki. All participants and their legal guardians were provided with a detailed

explanation of the study's objectives and procedures. Informed consent and/or assent were obtained before enrolment, ensuring that participants fully understood the purpose of the study, the procedures involved, and their personal information would be kept confidential.

Study setting and location: The research was undertaken at the Unit of the Clinical Haematology Department at S.C.B. Medical College and Hospital, as well as the Department of Oral Medicine and Radiology at S.C.B. Dental College and Hospital, situated in Cuttack, India.

Study duration: The study lasted one year, from January 2024 to January 2025.

Study participants: Paediatric and adult patients aged 6-40 years suffering from beta-thalassemia and healthy controls with no history of craniofacial abnormalities or facial surgery.

Sample size and sampling method: To estimate the appropriate sample size, the Epitool online calculator was used, drawing reference from a previous study conducted by Anwaar A et al. [17]. The calculation incorporated a population standard deviation of 3.2, a 95% confidence level, and an allowable margin of error of 0.5, resulting in a required sample size of 150 participants, including males and females. A purposive sampling technique was adopted to selectively recruit individuals who met the study criteria and aligned with the research objectives.

Inclusion criteria:

- Individuals with a confirmed clinical diagnosis of β-Thalassemia Major, regardless of gender, religion, or socioeconomic background
- Patients between the ages of 6 and 40 years

Exclusion criteria:

- Individuals with comorbidities such as cardiac or hepatic failure, acute infections accompanied by fever (>38°C), chronic inflammatory conditions or infections, malignancies, or those who are pregnant
- Patients diagnosed with other forms of thalassemia other than beta thalassemia major

Study procedure and outcome measurements: After obtaining the necessary consent/ascent from the adult patients and caregivers/parents of children, clinical/medical and anthropometric measurements were carried out.

The medical examination included the patient's transfusion status, splenectomy status, and checking the patient's height (cm), weight (kg), body type, pallor, icterus, cyanosis, and oedema status.

Before the procedure, each participant—or their parent in the case of minors—received an explanation of the craniofacial anthropometric assessment process. For every subject, 16 specific measurements were recorded across five defined craniofacial regions: five about the face, three to the nose, three to the eyes, three to the lips and mouth, and two to the ears. Using callipers, the examiner identified and marked all relevant anatomical landmarks on the face with a surgical skin marker. Linear dimensions were then obtained directly from these marked points, applying only gentle contact with the soft tissues, following the standardized protocol described by Farka et al. [18]

1. **Face:** Face width (zy-zy), Face height (n-gn), Upper face height (n-sto), Maxillary depth (t-sn), Mandibular depth (t-gn).
2. **Nose:** Nose width (al-al), Nose height (n-sn), Nasal tip protrusion (sn-prn)
3. **Eyes:** Biorbital width (ex-ex), Intercanthal distance (en-en), Palpebral fissure length (en-ex).
4. **Mouth:** Mouth width (ch-ch), Lower lip height (sto-ls), Upper lip height (sn-sto).

5. **Ears:** Ear width (par- pa), Ear length (sa-sba).

STATISTICAL ANALYSIS

Data collected for each parameter were compiled using Microsoft Excel and analysed with IBM SPSS Statistics for Windows, Version 20 (IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was conducted for each variable to evaluate the distribution pattern, confirming normal distribution as no significant deviations were observed. Descriptive statistics were presented as means, standard deviations, and proportions. Since the data met the criteria for normality, parametric tests were applied. The chi-square test was used to analyse associations between categorical variables, and the student's t-test was employed to compare means across groups. Statistical significance was established at a threshold of $p < 0.05$.

RESULT

In both study groups, males comprised most participants, and age distribution was relatively even. Although the control group demonstrated a marginally higher mean age in both pediatric (6–16 years) and adult (17–40 years) subgroups, this difference did not reach statistical significance. Most participants resided in Cuttack (42%), followed by Kendrapada (21.3%) and Jajpur (14.7%).

Medical outcomes:

Within the thalassemia cohort, the mean age at initial diagnosis was 9.75 ± 11.31 months. On average, these patients had undergone 222 ± 129 blood transfusions. Their mean height and weight were 138.36 ± 14.09 cm and 32.41 ± 10.43 kg, respectively, indicative of the clinical and growth characteristics associated with the condition.

Table 1: Anthropometric measurements of beta-thalassemia patients and controls

	OFM Parameters	Thalassemia (N=150)	Control (N=150)	P value
Face	Face width (zy-zy)	101.81±6.09	119.01±6.87	< 0.0001*
	Facial height (n-gn)	105.61±6.88	117.31±6.17	< 0.001*
	Upper facial Morphological height (n-sto)	73.10±5.11	71.64±7.03	< 0.0001*
	Maxillary depth (t-sn)	110.51±5.95	96.21±5.83	< 0.0001*
	Mandibular depth (t-gn)	117.93±7.65	127.30±7.72	< 0.0001*
Nose	Nasal width (al-al)	32.69±2.38	35.46±3.53	< 0.0001*
	Nasal height (n-sn)	50.20±3.59	54.59±4.34	< 0.0001*
	Nasal length (sn-prn)	14.21±1.60	21.22±2.35	< 0.0001*
Mouth	Mouth width (ch-ch)	43.25±4.61	48.34±4.03	< 0.0001*
	Lower third face height (sn-gn)	55.59±6.19	67.71±6.16	< 0.0001*
	Mouth opening	41.90±4.69	45.61±5.34	< 0.0001*
Eye	Outer eye space (ex-ex)	90.59±6.54	94.87±4.95	< 0.0001*
	Inner corner eye space (en-en)	31.48±2.61	32.67±3.05	0.0003
	Eye length (en-ex)	30.86±3.57	27.12±2.44	< 0.0001*
Ear	Ear width (pra-pa)	28.83±2.83	32.11±2.88	< 0.001*
	Ear Height (sa-sba)	51.56±5.81	59.09±5.39	< 0.0001*

Student t test; p<0.05*

[g-Glabella; ft-Frontotemporale; zy-Zygion; go-Gonion; sl-Sublabiale; pg-Pogonion; gn- Gnathion; en-Endocanthion; ex-Exocanthion; ps-Palpebrale superius; pi-Palpebrale inferius; n-Nasion; mf-Maxillofrontale; al-Alare; prn-Pronasale; sn-Subnasale; ls-Labiale superius; li-Labiale inferius; ch-Cheilion; sa-Superaurale; sba-Subaural]

The quantitative analysis of anthropometric measurements revealed marked morphological differences between β-thalassemia patients and controls, with most parameters showing statistically significant differences ($p < 0.0001$). Facial width (zy–zy) and height (n–gn) were notably reduced in thalassemia patients (101.81 mm and 105.61 mm, respectively) compared to controls, suggesting generalized facial narrowing and vertical growth restriction. While upper facial morphological height (n–

sto) was slightly greater in the thalassemia group, maxillary depth (t–sn) was markedly increased (110.51 mm vs. 96.21 mm), indicating maxillary protrusion, whereas mandibular depth (t–gn) was reduced, reflecting mandibular retrusion. Nasal parameters, including width, height, and length, were consistently reduced, highlighting midfacial hypoplasia. Mouth width, lower third facial height, and mouth opening were significantly smaller in patients, consistent with reduced oral aperture and vertical facial deficiency. Ocular parameters slightly decreased outer eye space and inner canthal distance. However, eye length (en–ex) was greater in the thalassemia group, possibly due to altered orbital morphology. Ear width and height were significantly smaller, reflecting overall craniofacial underdevelopment. These measurements quantitatively substantiate the classical dysmorphic features of β-thalassemia, including midfacial deficiency, maxillary prominence, and reduced lower facial proportions. (Table 2)

Table 2: Blood group differences of orofacial measurements (OFM) of B thalassemia patients

Blood group	A+	B+	O+	AB+	P value
Face					
Face width (zy-zy)	103.34±6.06	103.63±5.93	101.85±6.33	109.50±5.57	0.006*
Facial height (n-gn)	106.62±8.12	108.38±6.23	107.88±8.21	112.4±7.52	0.283
Upper facial Morphological height (n-sto)	73.29±5.11	74.91±5.90	75.89±7.40	73.37±4.14	0.257
Maxillary depth (t-sn	110.58±6.98	112.00±4.89	113.08±6.41	113.37±10.57	0.315
Mandibular depth (t-gn)	117.82±9.36	118.69±6.27	120.84±8.47	123.63±7.68	0.116
Nose					
Nasal width (al-al)	32.54±2.56	32.92±2.19	33.60±3.52	35.38±2.42	0.039*
Nasal height (n-sn)	51.60±4.52	51.41±2.99	52.03±5.30	49.58±3.25	0.463
Nasal length (sn-prn)	14.36±1.87	14.77±1.43	13.98±2.15	14.96±2.06	0.137
Mouth					
Mouth width (ch-ch)	41.50±4.17	43.78±3.73	44.03±4.89	47.46±3.06	0.001*
Lower third face height (sn-gn)	54.72±7.57	57.64±4.95	55.66±6.21	62.98±4.43	0.001*
Mouth opening	41.52±3.54	41.55±5.95	40.50±3.84	47.44±5.50	0.001*
Eye					
Outer eye space (ex-ex)	90.31±5.85	92.86±5.22	89.28±6.12	98.98±4.66	<.0001*
Inner corner eye space (en-en)	31.85±3.05	31.58±2.48	31.94±3.05	32.88±1.83	0.629
Eye length (en-ex)	30.74±2.94	31.51±3.39	30.01±2.92	34.23±3.14	0.001*
Ear					
Ear width (pra-pa)	29.81±3.28	29.20±2.68	28.59±2.75	31.28±2.55	0.034*
Ear Height (sa-sba)	50.88±4.98	52.34±5.86	51.07±4.94	50.27±10.25	0.529

The analysis of orofacial measurements across different blood groups in β-thalassemia patients revealed significant morphological variation in several parameters. Patients with the AB+ blood group consistently demonstrated the highest mean values in multiple dimensions, including face width, mouth width, lower third face height, mouth opening, outer eye space, and eye length, all of which showed statistically significant differences ($p < 0.05$). Notably, AB+ individuals also had the widest nasal width, suggesting a broader overall facial structure compared to other blood groups. Conversely, parameters such as facial height, upper facial morphological height, maxillary and mandibular depth, nasal height, and inner canthal distance showed no significant differences among blood groups, indicating relative stability of these traits irrespective of blood type. The O+ group generally exhibited intermediate values, while A+ and B+ groups showed modest variations without a consistent trend. These findings suggest that certain craniofacial dimensions, particularly transverse facial and oral widths as well as ocular spacing, may be more influenced by

blood group-related factors in β-thalassemia patients, with AB+ individuals tending towards broader facial morphologies. **(Table 3)**

Table 3: Correlation between parameters

Correlation parameters	r value	P value
Serum ferritin and mean height	**-0.073**	**0.369**
Serum ferritin levels and weight	**-0.070**	**0.389**

The correlation analysis revealed no statistically significant associations between the examined parameters. Serum ferritin levels showed weak, negative correlations with mean height (r = –0.073) and weight (r = –0.070), suggesting a minimal inverse relationship between iron. These findings imply that variations in iron load or detection timing within this study population had a negligible measurable impact on growth parameters or craniofacial deformity severity.

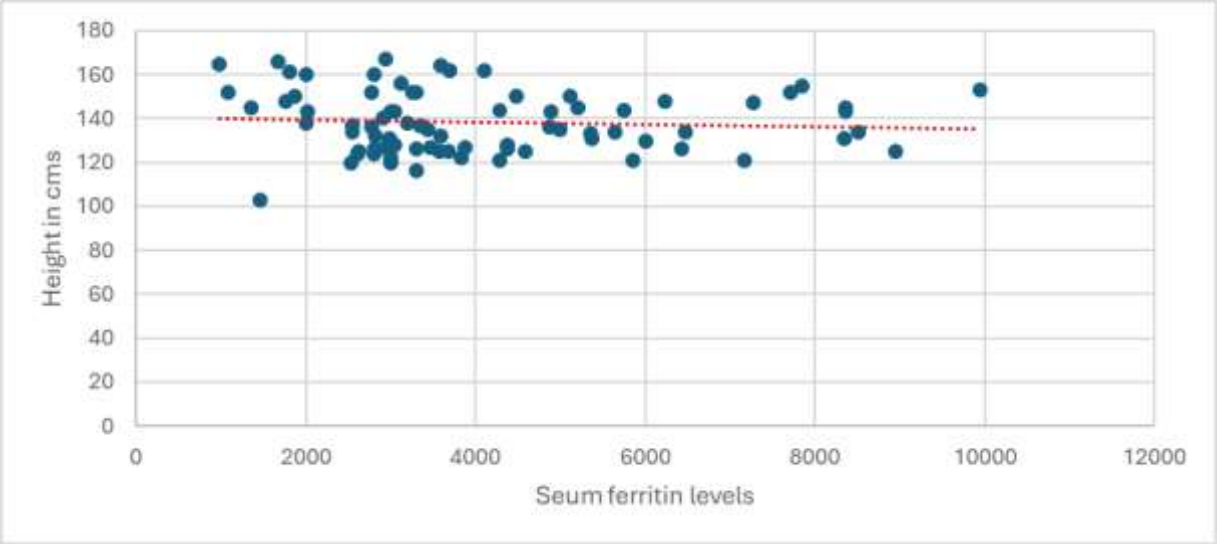

Figure 1: Correlation between serum ferritin levels and height

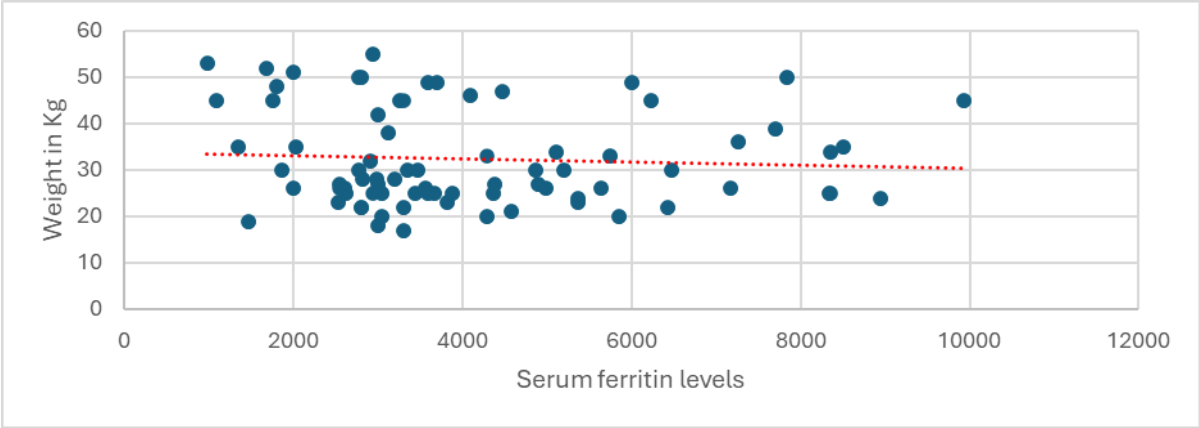

Figure 2: Correlation between serum ferritin levels and weight

DISCUSSION

This cross-sectional hospital-based comparative study comprehensively evaluates 15 craniofacial anthropometry measurements in β-thalassemia major patients versus matched healthy controls, revealing marked structural differences that correlate with disease pathology and bone marrow expansion. The results underscore quantitative and qualitative disparities in orofacial morphology, with significant

implications for clinical management and multidisciplinary care.

The review of existing literature highlighted a paucity of studies assessing craniofacial anthropometric measurements in thalassemia patients. In Syria, Takriti et al. [13] conducted a cephalometric study comparing skeletal and dental craniofacial parameters of 51 thalassemia major patients with those of healthy age-matched controls. Their findings showed increased prevalence of Class II malocclusion, characterized by maxillary prognathism and mandibular retrognathia, along with reduced posterior facial height and increased anterior facial height among thalassaemic patients compared to their regular counterparts. On the other hand, a study by Alhaija et al. [9], in Qatar, evaluated lateral cephalograms of 37 thalassemia patients aged 5–16 years and reported a predominance of Class II skeletal patterns, with maxillary dimensions within normal limits. The reduced cranial base length observed in these patients was attributed to a shortened mandible.

Several anthropometric and cephalometric reports describe a high frequency of midface changes and Class II tendencies among transfusion-dependent patients. However, reported prevalence varies widely between series because of differences in age structure, ethnic background, and transfusion/chelation history [11,19-21]. Our findings are closest to studies from regions where late diagnosis and variable transfusion regimens are common, which report a similarly high burden of moderate–severe deformity; by contrast, cohorts with early, well-maintained transfusion and chelation programs tend to show milder deformities and higher proportions of patients with normal facial morphology [21,22].

In an Indian study, Girinath et al. [23] reported that 84% of β-thalassemia major patients exhibited oral and maxillofacial changes, including protrusion of the upper and lower jaws, saddle-shaped nose, spacing and protrusion of the anterior teeth, and frontal bossing. They noted that the severity of these orofacial alterations increased with deteriorating general health and declining haematological parameters. Furthermore, they suggested that early initiation of blood transfusions could reduce the prevalence of such oral and maxillofacial changes.

Quantitatively, we observed significantly reduced facial width (zy–zy) and total facial height (n–gn) in thalassemia patients, alongside a notably increased maxillary depth (t–sn) and decreased mandibular depth (t–gn), a combination that translates clinically into midface prominence with mandibular retrusion and vertical facial restriction. These specific linear results mirror shape-based and cephalometric work: geometric morphometric analyses have shown a more convex, hyperdivergent craniofacial shape with midface protrusion and reduced posterior facial height in β-thalassemia patients [19], and multiple cephalometric studies have reported smaller mandibular bodies, reduced posterior facial height, and relative maxillary projection consistent with a Class II pattern [9]. Some anthropometric series reports less pronounced or inconsistent changes in facial width, especially across sexes and ethnic groups [21,22]. Such discrepancies likely reflect differences in sample age (children versus adults), landmark selection (soft-tissue anthropometry vs radiographic landmarks), and the cumulative effect of long-term transfusion/chelation. Our linear anthropometrics support the same mechanistic picture derived from radiographic shape analyses: marrow expansion preferentially affects maxillary bones and posterior facial height, while mandibular growth is relatively constrained.

Nasal, oral, and perioral measurements in our cohort also diverged from controls: nasal width, height, and length were reduced (midfacial hypoplasia), while mouth width, lower third facial height, and mouth opening were smaller, consistent with a reduced oral aperture and vertical deficiency. These findings align well with multiple anthropometric and clinical reports documenting flattened nasal bridges,

diminished nasal projection, and reduced lower facial proportions in thalassemia patients [11,21,22]. Several imaging and CT-based investigations additionally describe maxillary sinus changes and alterations in nasal cavity anatomy that accompany bone remodelling in longstanding disease, thereby providing radiologic corroboration of our soft-tissue measurement. Some studies, however, report greater variability in nasal indices depending on ethnicity and age; this reinforces the importance of matched regional normative data when interpreting absolute metric differences. Clinically, the combined midface hypoplasia and smaller oral aperture we document can explain the frequent dental crowding, increased overjet, and functional limitations reported elsewhere, and argues for early dental surveillance in affected children [19,20].

Ocular and auricular dimensions showed a mixed pattern in our data: a slight reduction in outer and inner canthal distances but an increased palpebral length (en–ex) and significantly smaller ear width and height. Prior studies are similarly mixed for orbital measurements but more consistent for ear dimensions: several anthropometric series reports reduced auricular size in thalassemia cohorts, consistent with generalized craniofacial underdevelopment [11,21]. The divergence in palpebral length is less commonly described and may reflect soft-tissue compensations, measurement technique differences (soft-tissue vs osseous landmarks), or sampling effects; geometric morphometric and cephalometric analyses have focused more on bony outlines (maxilla, mandible, cranial base) than on subtle soft-tissue palpebral metrics, so direct comparisons are limited [19]. Given the heterogeneity of prior reports, our orbital/ocular results should be interpreted cautiously. They could profitably be re-examined in future work using 3D surface imaging or imaging-based landmarking to separate soft-tissue from skeletal contributions.

We found no statistically significant correlations between single-time-point serum ferritin and height or weight, nor between CFD severity and age at diagnosis. This mirrors prior observations emphasizing ineffective erythropoiesis and chronic marrow hyperplasia, rather than a single biochemical snapshot of iron load, as the primary driver of skeletal remodelling [19,20]. Studies have suggested that early, regular transfusion (which suppresses marrow hyperplasia) and effective chelation (which reduces long-term endocrine sequelae) attenuate facial deformity; conversely, once extensive bone remodelling has occurred, cross-sectional biochemical markers such as a current ferritin value are poor proxies for cumulative skeletal change [19,20]. Therefore, the absence of strong ferritin–anthropometry correlations in our cohort is consistent with the interpretation that craniofacial remodelling is largely time-integrated and more dependent on the historical adequacy of transfusion and the duration of ineffective erythropoiesis than on contemporaneous iron indices.

The pathophysiologic and clinical implications of these comparisons are clear. Mechanistically, the literature converges on hypertrophy of erythroid marrow with cortical thinning and bone expansion (especially of the maxilla and cranial vault) as the proximate cause of the craniofacial phenotype; our anthropometric profile (midface protrusion, mandibular retrusion, vertical deficiency, nasal hypoplasia and reduced oral/auricular dimensions) maps directly onto that mechanism and to modern radiographic descriptions [9,19]. Clinically, the consistency of our results with prior cephalometric and anthropometric series supports routine early dental and orthodontic screening, close coordination with haematology for perioperative/transfusion planning, and cautious surgical planning because of bone fragility and bleeding risks described in the orthodontic/surgical literature [9,20].

In the present study, significant variations in orofacial dimensions among beta-thalassemia patients were observed across different blood groups, with AB+ individuals exhibiting greater facial width, nasal width, mouth width, lower third facial height, mouth opening, outer eye space, eye length, and ear width compared to other groups. These findings suggest a possible influence of blood group on the expression of craniofacial phenotypes in thalassemia, which aligns with earlier studies reporting considerable heterogeneity in craniofacial morphology among affected patients due to genetic and haematological factors rather than environmental influences. The present observations, therefore, extend prior evidence by highlighting that the ABO blood group may further modulate the severity of craniofacial deformities, particularly in AB+ patients, thereby warranting further genetic and anthropometric investigations. Only one study by Mohammed et al [24] has analysed the anthropometric measurements based on blood groups, which did not find any significant differences based on the blood groups.

Strengths of the present work include a well-matched control group, a broad set of direct anthropometric measurements spanning facial, nasal, oral, ocular, and auricular regions, and a sample drawn from the regional referral base, all of which permit meaningful comparisons with published series. Limitations mirror those in the literature: cross-sectional design (which cannot map longitudinal progression), absence of radiographic 3D or geometric morphometric analyses in every subject, and potential residual confounding by nutritional status or treatment history. Future longitudinal studies that combine direct anthropometry with cephalometry and 3D surface/CBCT morphometrics, stratified by transfusion/chelation adequacy and age at treatment initiation, would best clarify the timing and modifiability of these craniofacial changes.

CONCLUSION

In summary, our data corroborate and extend prior anthropometric and radiographic studies: β-thalassemia major patients show a reproducible pattern of midfacial prominence with mandibular retrusion, vertical facial restriction, nasal hypoplasia, and reduced oral/auricular dimensions. Differences in absolute metrics across published cohorts are primarily explained by population, age, and treatment heterogeneity, but the directional pattern of craniofacial alteration is robust and consistent across methodologies. These convergent findings reinforce the need for early, multidisciplinary craniofacial assessment and treatment strategies that account for this patient population's unique anatomical and hematologic context.

Declaration by Authors

Ethical Approval: The study was approved from the Institutional Ethics Committee of S.C.B. Dental College and Hospital, Cuttack, Odisha (Reference No. IEC/SCBDCH/205/2022, dated 09/08/2023), and was conducted by the ethical principles of the Declaration of Helsinki.

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Conflict of Interest: The authors declare no conflict of interest.

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