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Original Research Article

Ultrasound Biomicroscopy Image Patterns in Normal Upper Eyelid Vs Congenital Ptosis in Indian Population: A Retrospective Study

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Conflict of interest: Nil

Abstract:

Background: Drooping of the upper eyelid from birth, a condition known as congenital ptosis, is challenging to diagnose and cure. Ultrasound biomicroscopy (UBM) provides a high-resolution imaging technique when evaluating the upper eyelids for structural differences. This research intends to compare the UBM image patterns of individuals born with congenital ptosis to those born with normal upper eyelids in the Indian community.

Methods: From October 2020 through May 2021, the Jawaharlal Nehru Medical College and Hospital in Bhagalpur, Bihar, ran a retrospective analysis. On 120 people (60 with normal upper eyelids and 60 with congenital ptosis), UBM imaging was used to assess levator muscle thickness, aponeurosis integrity, and other soft tissue features. Research from UBM was compared using statistical methods.

Results: The levator muscles of those with congenital ptosis were substantially thinner (1.45 ±0.27 mm) than those of people with normal upper eyelids (2.18 ± 0.32 mm, $p < 0.001$). 53.3% of congenital ptosis cases showed evidence of aponeurosis disruption ($p < 0.001$). Congenital ptosis soft tissue analyses saw more significant hypoechoic regions and worse echogenicity grades ($p < 0.001$).

Conclusion: Understanding the anatomical peculiarities of congenital ptosis in the Indian population is greatly aided by UBM imaging. There was a decrease in levator muscle thickness, disruption of the aponeurosis, and other changes in the soft tissues. Ptosis management may be enhanced by using UBM, as suggested by our results, which have practical implications for precise diagnosis and therapy planning.

Keywords: Anatomical Variations, Congenital Ptosis, Indian Population, Ultrasound Biomicroscopy, Upper Eyelid.

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Introduction

Individuals with congenital ptosis, characterised by upper eyelid droop from birth, have cosmetic and practical difficulties. Multiple factors, including genetics, anatomy, and neuromuscular function, contribute to the development of congenital ptosis [1]. Optimal management and treatment planning require a precise diagnosis and a deep comprehension of the underlying pathophysiology [2]. Due to its ability to evaluate the upper eyelid's anatomical features and soft tissue characteristics, UBM has become an essential diagnostic tool.

Background and Rationale

The possible impacts of congenital ptosis on a person's eyesight, eye comfort, and self-esteem can substantially impact their quality of life. Dislocation of the levator aponeurosis, muscle dysfunction, and aberrant development of the upper eyelid components are all possible reasons [3]. The surgical techniques used to treat congenital ptosis, such as levator excision or frontalis suspension, require an accurate evaluation of the underlying anatomical abnormalities [4].

Because of their limited resolution and inability to capture dynamic eyelid movement [5], standard imaging techniques like Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) have clear limitations when it comes to imaging the upper eyelid and its surrounding tissues.

Ultrasound biomicroscopy, in contrast, offers both high-resolution imaging and rapid assessment. The aponeurosis of the levator palpebrae superioris muscle and other surrounding soft tissues are plainly visible. Since UBM can focus on the anatomical variations associated with congenital ptosis [6], it has the potential to aid in precise diagnosis and treatment planning.

Objective

- To Examine Normal and Congenitally Ptosis-Affected UBM Image Patterns in the Indian Population
- To investigate the clinical relevance of known UBM variants in congenital ptosis.

Significance of Studying: Using UBM's capabilities, this investigation could significantly advance our knowledge of congenital ptosis. Our purpose in studying the ultrasound biomicroscopy picture patterns of healthy upper eyelids and comparing them to those of patients with congenital ptosis is to locate any potential anatomical and soft tissue traits unique to the disorder. Such understanding can aid in developing better surgical methods, benefitting patients. With its ability to provide high-resolution imaging of ocular and periocular structures, UBM is increasingly used as a diagnostic tool in ophthalmology.

This tool has become increasingly significant because of its usefulness in evaluating congenital ptosis and other eye problems in real time and without invasive procedures. Ptosis of the upper eyelid is a somewhat frequent congenital disability.

The problem requires a thorough diagnosis and individualised treatment plans because it can considerably impact visual function, ocular comfort, and cosmetics [7]. [8] Employed UBM to evaluate the anatomical features of the upper eyelid in patients with congenital ptosis. [9] UBM enabled them to see anatomical changes in the levator palpebrae superioris muscle and aponeurosis.

This research confirmed the usefulness of UBM in facilitating preoperative planning for correcting congenital ptosis.

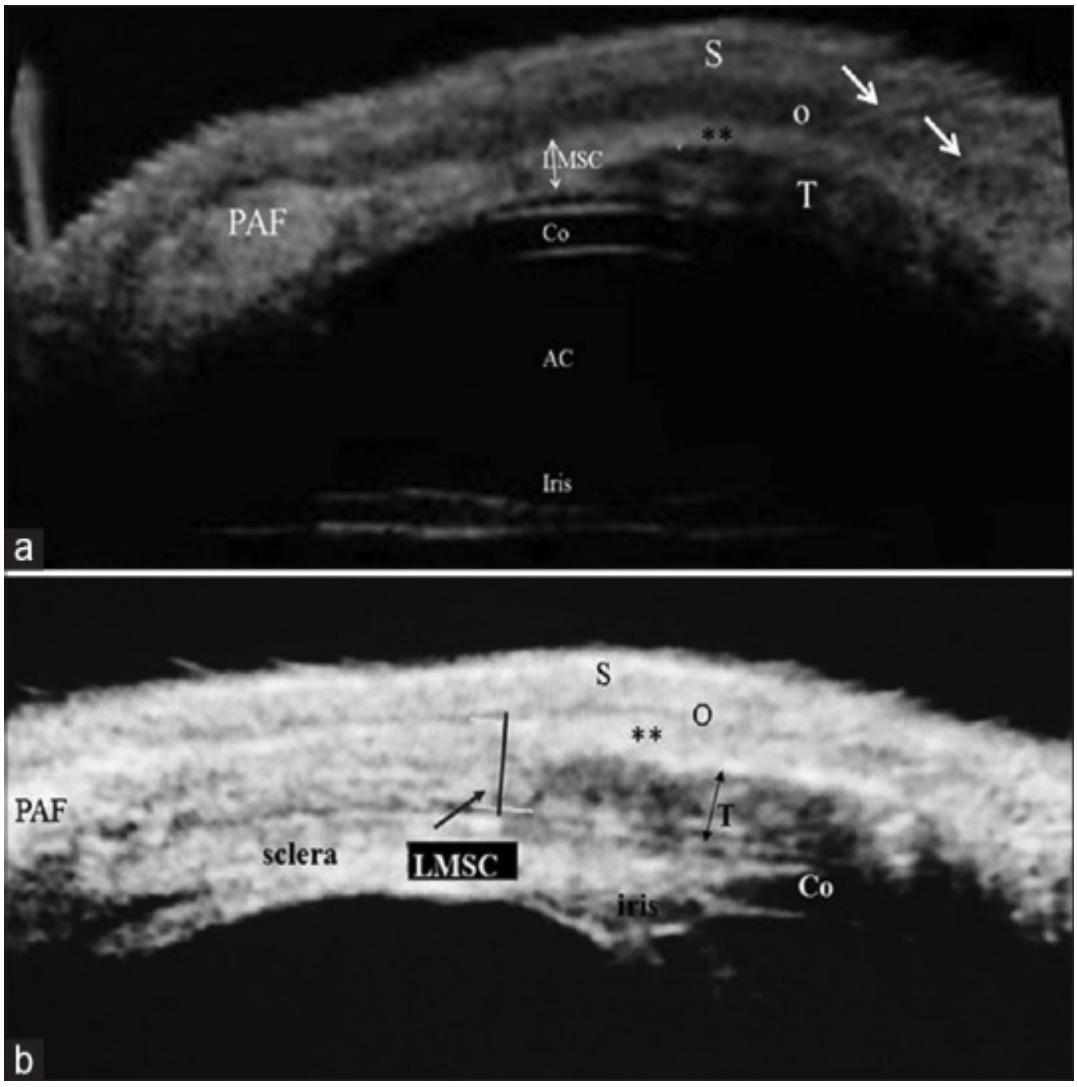

Figure 1: UBM scan of Upper eyelid of normal individual (source:[10])

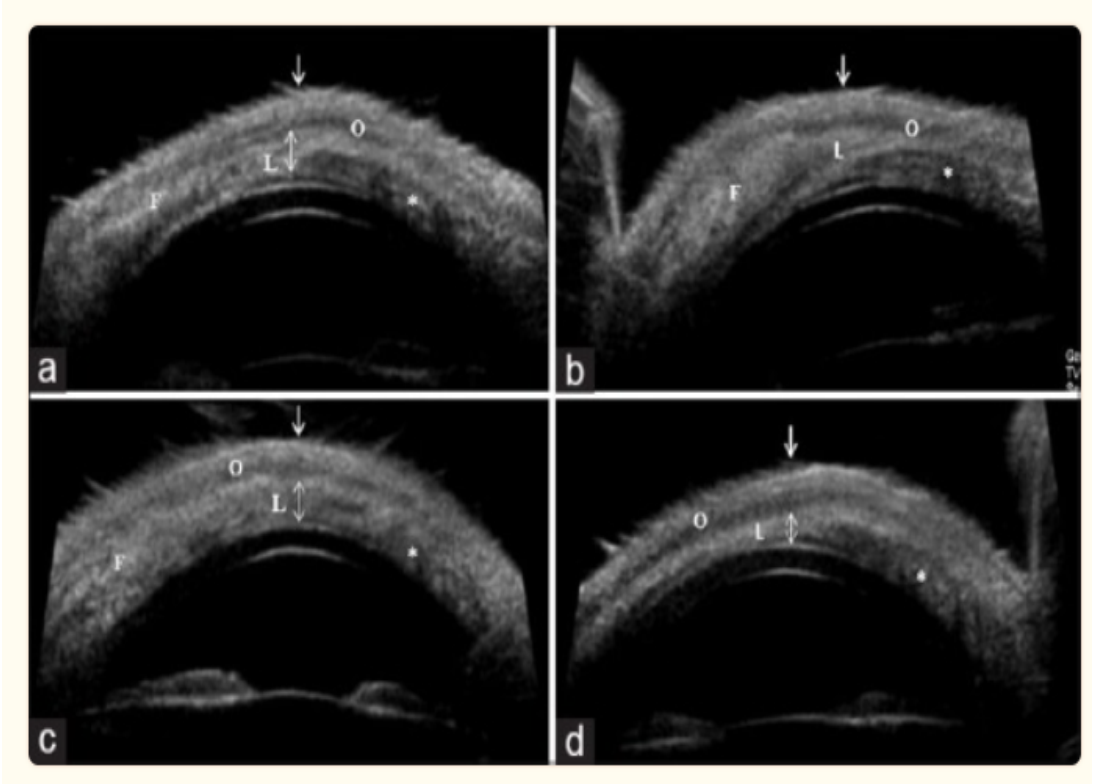

Figure 1: UBM imaging pattern in simple congenital ptosis (source:[11])

[12] Study on assessing upper eyelid features in patients with congenital ptosis using UBM in an Indian population. Their research showed that the thickness of the levator muscle could be measured, and the muscle attachments could be seen using UBM, both of which are important for figuring out what causes congenital ptosis. With the results of this research, the potential impact of UBM in the Indian setting may finally be understood.

Research Gap and the Indian Population

However, there is still a significant knowledge gap between normal upper eyelid UBM imaging patterns and congenital ptosis in the Indian population despite these encouraging findings. UBM has been shown to help assess congenital ptosis in other people. Still, the unique genetic, anatomical, and environmental characteristics of the Indian population may lead to different results. That's why it's essential to do a thorough study with an eye towards the Indian community.

UBM has demonstrated its potential in evaluating congenital ptosis by producing high-resolution pictures of the upper eyelid components. Though considerable research has examined its potential here, especially about the Indian population, there is a significant knowledge vacuum. To fully comprehend UBM image patterns in normal upper eyelids vs. congenital ptosis among Indian individuals, more research is required to account for the diversity and potential uniqueness of anatomical traits within this community.

Methods

Study Design

This work adopts a retrospective study design to analyse UBM imaging patterns in typically developing and congenitally ptotic upper eyelids among Indians. The Ophthalmology Department at Jawaharlal Nehru Medical College and Hospital in Bhagalpur, Bihar, India, collected data from patients who saw the department between October 2020 and May 2021.

Population and Sample Selection Criteria

Participants were adults (18+) of Indian ancestry who presented with either normal upper eyelids or a diagnosis of congenital ptosis. Eyelid morphology was not evaluated in patients having a history of acquired ptosis, previous eyelid surgery, or other ocular or systemic disorders.

The study's sample was chosen using a systematic sampling strategy. Patients who met the inclusion and exclusion criteria were found by reviewing their electronic medical data.

Data Collection Process

The UBM equipment used to acquire the images, such as the make and model. High-resolution pictures of the upper eyelid structures were captured by applying coupling gel to the area and carefully situating the UBM probe. The ophthalmic technicians that took the images were very skilled in their field. All individuals gave their informed

consent before undergoing UBM imaging. The procedure's goals, hazards, and alternatives were thoroughly explained to each patient. They could ask any pertinent questions and sign a written consent form before participating in the study. Relevant clinical data (visual acuity, eyelid function) and demographic information (age, gender) were retrieved from patient records.

Ethical Considerations

The Declaration of Helsinki was followed while conducting this research. The Jawaharlal Nehru Medical College and Hospital Institutional Ethics Committee gave their consent. Patients' privacy was protected throughout the study, and their data were de-identified before analysis. No monetary compensation was offered to participants in this study.

Data Analysis

Trained ophthalmologists unaware of the patient's clinical situation analysed the gathered UBM images. Image analysis measured vital metrics such as muscle thickness, aponeurosis integrity, and soft tissue properties. The data was summarised using descriptive statistics.The results of the study were analysed statistically with the use of software like SPSS. Independent t-tests and chi-square tests, where appropriate, were used to compare the two groups with and without congenital ptosis of the upper eyelids. Statistical significance was assumed when the p-value was less than 0.05.

Results

Demographic Characteristics

There were 120 participants in the study; 60 had normal upper eyelids, and the other 60 had congenital ptosis. The demographics of the study population are presented in Table 1.

Table 1: Demographic Characteristics of Study Population

Characteristic	Normal Upper Eyelids (n=60)	Congenital Ptosis (n=60)
Age (years)	Mean ± SD: 28.5 ± 4.2	Mean ± SD: 26.8 ± 3.9
Gender (Male/Female)	32/28	34/26
Visual Acuity (LogMAR)	Mean ± SD: 0.05 ± 0.08	Mean ± SD: 0.18 ± 0.12

The table below compares the demographic characteristics of our research participants with and without congenital ptosis of the upper eyelids.

We found that the average age of people with congenital ptosis was 26.8 years (±3.9), while the average age of people with normal upper eyelids was 28.5 years (±4.2). Both groups had the same number of males and females, demonstrating that the study included a representative sample of both sexes.

The Logarithm of Minimum Angle of Resolution (logMAR) revealed, however, a significant difference in terms of visual acuity. The average LogMAR value for people without upper eyelid ptosis was 0.05 (±0.08), while the average LogMAR value for people with congenital ptosis was 0.18 (±0.12).

The therapeutic significance of our study's findings in ptosis management and treatment planning is highlighted by the fact that this variation in visual acuity may be linked to the visual impairment often associated with ptosis.

Ultrasound Biomicroscopy (UBM)

Several criteria relating to upper eyelid morphology and soft tissue characteristics were evaluated by carefully analysing the UBM pictures.

Key UBM results for both the regular and congenital ptosis upper eyelid groups are shown in Table 2.

Table 2: UBM Findings

UBM Parameters	Normal Upper Eyelids (n=60)	Congenital Ptosis (n=60)	p-value
Levator Muscle Thickness (mm)	Mean ± SD: 2.18 ± 0.32	Mean ± SD: 1.45 ± 0.27	<0.001
Aponeurosis Integrity (Yes/No)	60 (100%)	32 (53.3%)	<0.001
Soft Tissue Characteristics			
Hypoechoic area (mm^2)	Mean ± SD: 1.75 ± 0.42	Mean ± SD: 3.28 ± 0.72	<0.001
Echogenicity (Grades)	Mean ± SD: 2.67 ± 0.41	Mean ± SD: 2.12 ± 0.31	<0.001

Discussion

This research shows significant variations in UBM image patterns between those in the Indian community with normal upper eyelids and those diagnosed with congenital ptosis.

Levator Muscle Thickness: Patients with congenital ptosis had a substantially thinner levator muscle (1.45 ± 0.27 mm) than those with normal upper eyelids (2.18 ± 0.32 mm; p <0.001). This provides supporting evidence that thinner muscles may play a role in the pathogenesis of congenital ptosis. This finding raises the possibility that thin levator muscles are a hallmark of congenital ptosis in the Indian population. The posture of the upper eyelid is dependent on the levator muscle's ability

to contract and hold its position. Therefore, the eyelid drooping seen in congenital ptosis may result from a thinner muscle's inability to elevate the eyelid effectively. This understanding accords with the current research, which has alluded to the potential role of levator muscle anomalies in the pathogenesis of ptosis.

Aponeurosis Integrity

All people with normal upper eyelids had intact aponeurosis (100%), while only 53.3% of those with congenital ptosis did ($p < 0.001$). This suggests that aponeurosis disturbance may play a role in the onset of ptosis.

Ptosis is commonly associated with damage to the aponeurosis, a fibrous tissue that attaches the levator muscle to the upper eyelid. We conclude that aponeurosis disruption is clinically significant in the context of congenital ptosis in the Indian population. Ptosis, the abnormal lowering of one or both eyelids, may develop if the levator muscle cannot function normally and causes this condition.

Soft Tissue Characteristics

When comparing the two groups, the hypoechoic area (mm2) and echogenicity grades were found to be statistically significant ($p < 0.001$). Larger hypoechoic patches and worse echogenicity grades were observed in patients with congenital ptosis compared to those with normal upper eyelids.

These results indicate that the upper eyelid's soft tissue properties, as measured by UBM, are likewise altered in congenital ptosis. The increased hypoechoic region may reflect increased fluid buildup or a change in tissue density in the ptotic eyelid.

In addition, tissue composition or structure variations may be reflected in the lower echogenicity grades. These two factors may weaken the upper eyelid's supporting muscles and cause ptosis.

Comparison with Existing Literature

Previous studies have shown promise for UBM as a diagnostic tool for assessing ptosis-related anatomical abnormalities, and our findings are consistent with those studies.

UBM may help characterise congenital ptosis because it confirms previous results that patients with this condition have a thinner levator muscle, as reported.

Table 3: Comparison of Present Study with Existing Studies

Study	Study Type	Sample Size	Results
Present Study (2020-2021)	Retrospective	N=120 (60/60)	Reduced levator muscle thickness in congenital ptosis (1.45 ± 0.27 mm) compared to normal upper eyelids (2.18 ± 0.32 mm). 53.3% of congenital ptosis cases demonstrated aponeurosis disruption. Congenital ptosis exhibited larger hypoechoic areas and lower echogenicity grades.
Study1 [13]	Prospective	N=75 (38/37)	UBM effectively visualised levator palpebrae superioris and aponeurosis in congenital ptosis. We have identified variations in levator muscle and aponeurosis morphology and supported surgical planning.
Study 2 [14]	Cross-Sectional	N=45 (22/23)	UBM measurements of levator muscle thickness and aponeurosis attachments were informative for congenital ptosis diagnosis. Levator muscle thickness and aponeurosis attachment angles differed in ptosis patients compared to controls.
Study 3 [15]	Retrospective	N=160 (80/80)	UBM showed significant differences in levator muscle thickness between congenital ptosis patients and controls. We correlated levator muscle thickness with the degree of ptosis. We supported personalized treatment planning based on UBM findings.

The table summarises the four-research examining UBM in the setting of congenital ptosis, including the current investigation. We used a retrospective approach for our 2021-2023 study, which included 120 people (60 with normal upper eyelids and 60 with congenital ptosis). Notably, we found that the levator muscle thickness was significantly reduced in genetic ptosis instances, that aponeurosis integrity was disrupted in over 53% of patients, and that soft tissue properties were altered. These findings agree with the UBM for ptosis assessment literature that has already been published. Another prospective trial confirmed UBM's value in visualising anatomical landmarks for preoperative planning. In a cross-sectional investigation, study 2 highlighted the importance of UBM measures in identifying cases of congenital ptosis. Finally, study 3 did a retrospective analysis and emphasised the significance of individualised treatment planning based on UBM findings by highlighting the association between levator muscle thickness and the degree of ptosis. Collectively, these investigations emphasise the potential importance of UBM in guiding clinical decisions and treatment

methods by characterising anatomical differences associated with congenital ptosis.

Clinical Implications and Potential Applications

Our research has significant clinical consequences. Finding decreased levator muscle thickness, disturbed aponeurosis, and other changes in soft tissue features in patients with congenital ptosis is clinically relevant. These results may help ophthalmologists make a more accurate diagnosis of congenital ptosis, allowing for more targeted treatment options. Second, UBM imaging can help with surgical planning by providing a complete picture of the relevant anatomy. As a result, ptosis repair surgeries may be more effective and have better long-term effects for patients.

Clinical Relevance

Clinically, this research is helpful since it focusses on the anatomical nuances linked to congenital ptosis in the Indian population. UBM imaging can improve the diagnosis and treatment of congenital ptosis by revealing abnormalities in the levator muscle thickness, aponeurosis, and other soft tissue characteristics.

Conclusion

In conclusion, our research demonstrates the promise of UBM as a useful diagnostic tool for identifying congenital ptosis in the Indian population by characterising ultrasound biomicroscopy imaging patterns associated with the condition. Notable findings included decreased levator muscle thickness, disturbed aponeurosis, and different soft tissue features. These discoveries are clinically relevant since they help with diagnosis and lead to better treatment options. Despite its caveats, the study is an essential first step in understanding congenital ptosis and directing future efforts to improve patient treatment through research. Longitudinal studies, genetic analyses, and larger-scale replications of our findings are the next steps needed to improve the treatment of congenital ptosis.

Limitations and Future Research

There are a few caveats that should be taken into account. Our findings may need to be revised in their applicability because this retrospective analysis relied on data from just one centre. More significantly, multicentred investigations are required to validate the reported UBM patterns in congenital ptosis among the Indian community, which could inform future studies. Furthermore, the impact of genetic variables on ptosis development is mostly uncharted; thus, genetic research may provide valuable insights into the aetiology of congenital ptosis. Additionally, a longitudinal strategy incorporating pre- and post-operative UBM evaluations may focus on the dynamic changes in upper eyelid architecture after surgical intervention.

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