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Clinical and Epidemiological Characteristics of Patients Undergoing Strabismus Surgery at a Tertiary Referral Hospital in Brazil: A Retrospective Study

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Abstract

Strabismus may affect binocular visual development and psychosocial well-being. This study aimed to characterize the demographic and clinical features of patients undergoing strabismus surgery at a tertiary referral hospital in northeastern Brazil.

A retrospective, cross-sectional, descriptive study was conducted using medical records of patients who underwent strabismus surgery between January 2017 and December 2022. For patients who underwent multiple procedures during the study period, only the first surgery was considered. Demographic characteristics, strabismus classification, refractive status, selected clinical manifestations, ocular and systemic comorbidities, and relevant clinical histories were analyzed using descriptive statistics.

A total of 242 patients were included. The mean age at surgery was 16.3 ± 14.7 years, and 48.8% were aged 10 years or younger. Female patients accounted for 62.0% of the cohort. Horizontal strabismus was the most frequently documented classification (76.4%), with esotropia accounting for 65.4% of horizontal cases. Mixed strabismus was documented in 19.4% of patients, and bilateral involvement was recorded in 60.3%. Hyperopia was the most frequently documented refractive category (79.3%), followed by myopia (9.9%), emmetropia (8.3%), and antimetropia (1.2%). Diplopia and abnormal head posture were documented in 11.2% and 14.0% of patients, respectively. Ocular comorbidities were identified in 57 patients (23.6%), including amblyopia in 14 (5.8%), while systemic comorbidities were documented in 47 (19.4%), including neurological conditions in 17 (7.0%) and thyroid disorders in eight (3.3%). A history of trauma was documented in 23 patients (9.5%), and a family history of strabismus was documented in 19 (7.9%).

This study provides a descriptive characterization of patients undergoing strabismus surgery at a tertiary referral hospital in northeastern Brazil. The predominance of horizontal deviations, particularly esotropia, the frequent documentation of hyperopia, and the presence of associated ocular and systemic conditions characterize this surgical population. These findings provide regional data on the clinical profile of patients undergoing strabismus surgery and may contribute to future epidemiological research.

Categories: Ophthalmology, Pediatrics, Epidemiology/Public Health
Keywords: epidemiology, esotropia, exotropia, strabismus, strabismus surgery

Introduction

Strabismus is characterized by ocular misalignment and may result from abnormalities in the sensory or motor mechanisms responsible for binocular vision. It is a relatively common ocular condition, with reported prevalence varying across populations and age groups [1,2]. Beyond ocular misalignment, strabismus may be associated with amblyopia, diplopia, abnormal head posture, impaired binocular vision, and psychosocial consequences that may negatively affect quality of life [3].

Surgical intervention may be indicated when nonsurgical management is insufficient to achieve satisfactory ocular alignment or when the deviation causes significant functional or clinical impairment [4]. The clinical presentation of strabismus varies according to age, underlying etiology, and deviation characteristics. Consequently, the profile of patients undergoing surgical treatment may differ from that of the general population with strabismus, particularly in tertiary referral settings [5,6].

In Brazil, specialized ophthalmologic care within the Unified Health System (Sistema Único de Saúde, SUS) is organized through a regionalized healthcare network, with referrals determined by local healthcare arrangements and service availability [7,8]. Tertiary referral hospitals provide surgical care to patients referred from different healthcare facilities and geographic regions. However, the characteristics of patients

treated at these institutions may reflect referral patterns and institutional surgical practices rather than the epidemiological distribution of strabismus in the general population [9,10].

Although previous Brazilian studies have described patients undergoing strabismus surgery, data from tertiary referral hospitals in northeastern Brazil remain relevant for characterizing the demographic and clinical features of this surgical population [9]. Describing these characteristics may provide additional regional information on the types of cases managed within specialized ophthalmologic services.

Therefore, this study aimed to characterize the demographic and clinical features of patients undergoing strabismus surgery at a tertiary referral hospital in Salvador, Brazil, including age, sex, strabismus classification, refractive status, selected clinical manifestations, associated comorbidities, and a history of trauma or familial strabismus.

Materials And Methods

Study design and setting

This retrospective, cross-sectional, descriptive study was conducted at Hospital Universitário Professor Edgard Santos, affiliated with the Federal University of Bahia (HUPES-UFBA), a tertiary referral hospital located in Salvador, northeastern Brazil. The study included patients who underwent strabismus surgery between January 2017 and December 2022.

Study population

Patients were identified through the institution's surgical records of strabismus procedures performed between January 2017 and December 2022, followed by a review of the corresponding electronic medical records. A single physician retrospectively reviewed the medical records to assess eligibility and extract the relevant clinical information. The original clinical evaluations were performed by the healthcare professionals responsible for patient care.

For patients who underwent more than one strabismus surgery during the study period, only the first surgical procedure was considered. Subsequent procedures were excluded before the initial patient count, ensuring that each patient was represented only once in the study population.

A total of 255 patient records were initially assessed for eligibility. Four were excluded because the corresponding medical records were unavailable, and nine were excluded because the documentation was insufficient to establish eligibility and permit adequate clinical characterization. The final study population comprised 242 patients.

Patients with sufficient documentation to establish eligibility and permit basic clinical characterization were included even when information on individual variables was unavailable. Missing information for specific variables was classified as "not reported," when applicable, rather than being interpreted as the absence of the corresponding clinical finding.

Data collection and clinical variables

Data were retrospectively extracted from the institution's electronic medical records. Demographic variables included sex and age at the time of surgery. Clinical variables included strabismus classification, laterality of ocular deviation, refractive status, diplopia, abnormal head posture, documented ocular and systemic comorbidities, family history of strabismus, and history of trauma.

Strabismus was classified according to the direction of ocular deviation as horizontal, vertical, or mixed, based on the clinical findings documented in the medical records. Horizontal deviations were further categorized as esotropia or exotropia, whereas isolated vertical deviations were classified as hypertropia or hypotropia. Mixed strabismus was defined by the presence of both horizontal and vertical components in the same patient. Associated ocular motility abnormalities, including dissociated vertical deviation (DVD), oblique muscle overaction, and A- or V-pattern strabismus, were also considered during the clinical classification. Laterality was categorized as right-sided, left-sided, or bilateral involvement according to the preoperative clinical findings documented in the medical records.

Refractive status was assessed using the spherical equivalent (SE), calculated as the spherical power plus half of the cylindrical power, based on the cycloplegic refraction documented in the medical records. Myopia was defined as an SE of ≤ -0.50 diopters (D), hyperopia as an SE of ≥ +0.50 D, and emmetropia as an SE > -0.50 D and < +0.50 D. Refractive status was classified at the patient level according to the findings in both eyes. Patients with unilateral or bilateral hyperopia were classified as hyperopic, provided that the fellow eye was not myopic. Similarly, patients with unilateral or bilateral myopia were classified as myopic when the fellow eye was not hyperopic. Antimetropia was defined as the presence of hyperopia in one eye and myopia in the fellow eye, whereas emmetropia was assigned when both eyes met the emmetropic criteria. Cases with insufficient refractive information were classified as "not reported."

Diplopia and abnormal head posture were recorded according to their presence or absence in the preoperative clinical evaluation. When information regarding these variables was unavailable, the corresponding finding was classified as "not reported" rather than being considered absent.

Ocular comorbidities were identified from diagnoses documented in the medical records, including amblyopia, ptosis, congenital cataract, and other associated ophthalmological conditions. Systemic comorbidities were identified from the patients' medical records and categorized according to the documented diagnoses, including neurological conditions and thyroid disorders.

A positive family history of strabismus was recorded when the condition was reported in family members. History of trauma was classified according to the documentation of previous traumatic events, regardless of whether a causal relationship with strabismus had been established. Ocular and systemic comorbidities and clinical histories were analyzed as associated characteristics, without assuming an etiological relationship with ocular misalignment.

Statistical analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 19.0 (Released 2010; IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. Categorical variables were expressed as absolute frequencies and percentages, whereas continuous variables were summarized using means, standard deviations, medians, interquartile ranges, and minimum and maximum values, as appropriate.

Percentages were calculated using the total study population (N = 242) as the denominator, except for analyses restricted to specific strabismus subgroups, for which the corresponding subgroup size was used. Missing data were reported as a separate category when applicable, and no imputation procedures were performed. No inferential statistical tests were conducted, as the study was designed to provide a descriptive characterization of the surgical population.

Ethical considerations

This study was approved by the Research Ethics Committee of Hospital Universitário Professor Edgard Santos, Federal University of Bahia (HUPES-UFBA), Brazil, under Certificate of Presentation for Ethical Appreciation (CAAE) number 71066023.4.0000.0049. The study was conducted retrospectively using information obtained from institutional medical records.

Results

A total of 255 patient records were assessed for eligibility after subsequent surgical procedures in patients who underwent more than one strabismus surgery during the study period had been excluded. Of these, 13 records were excluded: four because the corresponding medical records were unavailable and nine because the available documentation was insufficient to establish eligibility and provide adequate clinical information. The final study population comprised 242 patients who underwent strabismus surgery between January 2017 and December 2022.

The mean age at surgery was 16.3 ± 14.7 years, with a median of 11.0 years (interquartile range: 6.0-22.8 years) and an age range of 1-73 years. Patients aged 10 years or younger accounted for 118 cases (48.8%). The age distribution was as follows: 17 patients (7.0%) were younger than two years, 39 (16.1%) were aged 2-5 years, 62 (25.6%) were aged 6-10 years, 57 (23.6%) were aged 11-20 years, 29 (12.0%) were aged 21-30 years, and 38 (15.7%) were older than 30 years. Female patients accounted for 150 cases (62.0%), while 92 (38.0%) were male. Regarding laterality of ocular deviation, bilateral involvement was documented in 146 patients (60.3%), right-sided involvement in 51 (21.1%), and left-sided involvement in 45 (18.6%) (Table *1*).

Variable	n (%) of total
Sex	
Female	150 (62.0)
Male	92 (38.0)
Age group	
<2 years	17 (7.0)
2-5 years	39 (16.1)
6-10 years	62 (25.6)
11-20 years	57 (23.6)
21-30 years	29 (12.0)
>30 years	38 (15.7)
Laterality of strabismus involvement	
Bilateral	146 (60.3)
Right-sided	51 (21.1)
Left-sided	45 (18.6)
Total	242 (100.0)

TABLE 1: Demographic characteristics and laterality of patients undergoing strabismus surgery

Continuous age: mean ± SD, 16.3 ± 14.7 years; median (IQR), 11.0 (6.0-22.8) years; range, 1-73 years.

Horizontal strabismus was the most frequently documented classification, observed in 185 patients (76.4%), followed by mixed strabismus in 47 (19.4%) and isolated vertical strabismus in 10 (4.1%). Among patients classified as having horizontal strabismus (n = 185), esotropia was identified in 121 (65.4%) and exotropia in 64 (34.6%). Among those with isolated vertical strabismus (n = 10), hypotropia was documented in seven patients (70.0%) and hypertropia in three (30.0%) (Table *2*).

Strabismus category	n (%) of total
Horizontal	185 (76.4)
Mixed	47 (19.4)
Vertical	10 (4.1)
Total	242 (100.0)
Horizontal strabismus subtype	
Esotropia	121 (65.4)
Exotropia	64 (34.6)
Total	185 (100.0)
Vertical strabismus subtype (n = 10)	
Hypotropia	7 (70.0)
Hypertropia	3 (30.0)
Total	10 (100.0)

TABLE 2: Distribution of strabismus types

Hyperopia was the most frequently documented refractive category, identified in 192 patients (79.3%), including eight patients with hyperopia in one eye and emmetropia in the fellow eye. Myopia was recorded in 24 patients (9.9%), while 20 (8.3%) were classified as emmetropic. Antimetropia, defined as hyperopia in one eye and myopia in the fellow eye, was documented in three patients (1.2%). Refractive status was not reported in three patients (1.2%) (Table *3*).

Refractive status	Number of patients (n)	Percentage (%)
Hyperopia	192	79.3
Myopia	24	9.9
Emmetropia	20	8.3
Antimetropia	3	1.2
Not reported	3	1.2
Total	242	100.0

TABLE 3: Refractive status

Diplopia was documented as present in 27 patients (11.2%) and absent in 196 (81.0%), while information regarding this symptom was unavailable for 19 patients (7.9%). Abnormal head posture was documented in 34 patients (14.0%) and recorded as absent in 203 (83.9%). Information regarding this finding was unavailable for five patients (2.1%) (Table *4*).

Diplopia	n (%)
Present	27 (11.2)
Absent	196 (81.0)
Not reported	19 (7.9)
Total	242 (100.0)
Abnormal head posture	**n (%)**
Present	34 (14.0)
Absent	203 (83.9)
Not reported	5 (2.1)
Total	242 (100.0)

TABLE 4: Diplopia and abnormal head posture

Note: For both variables, the absence of explicit documentation was not interpreted as a definitive absence of the finding. Cases without explicit documentation were classified according to the categories described above.

Ocular comorbidities were documented in 57 patients (23.6%), whereas 185 (76.4%) had no documented ocular comorbidities. The most frequently recorded ocular conditions included amblyopia in 14 patients (5.8%), ptosis in five (2.1%), and congenital cataract in four (1.7%). Systemic comorbidities were documented in 47 patients (19.4%). Among the reported conditions, neurological disorders were identified in 17 patients (7.0%) and thyroid disorders in eight (3.3%). A history of trauma was documented in 23 patients (9.5%), while 19 (7.9%) had a documented family history of strabismus (Table *5*).

Clinical characteristics	n (%)
Ocular comorbidities	
Present	57 (23.6)
Absent	185 (76.4)
Documented ocular diagnoses among patients with comorbidities	
Amblyopia	14 (5.8)
Ptosis	5 (2.1)
Congenital cataract	4 (1.7)
Systemic comorbidities	
Present	47 (19.4)
Documented systemic diagnoses among patients with comorbidities	
Neurological conditions	17 (7.0)
Thyroid disorders	8 (3.3)
Relevant clinical history	
History of trauma (positive)	23 (9.5)
Family history of strabismus (positive)	19 (7.9)

TABLE 5: Ocular and systemic comorbidities and relevant clinical history among patients undergoing strabismus surgery

The annual distribution of surgical cases varied throughout the study period. A total of 47 cases (19.4%) were recorded in 2017, 39 (16.1%) in 2018, 45 (18.6%) in 2019, 15 (6.2%) in 2020, 24 (9.9%) in 2021, and 72 (29.8%) in 2022. The lowest number of surgical cases was recorded in 2020, whereas the highest annual volume was observed in 2022 (Table *6*).

Year	Surgical cases, n	%
2017	47	19.4
2018	39	16.1
2019	45	18.6
2020	15	6.2
2021	24	9.9
2022	72	29.8
Total	242	100

TABLE 6: Annual distribution of strabismus surgery cases during the study period

Discussion

This six-year retrospective study describes the demographic and clinical characteristics of patients undergoing strabismus surgery at a tertiary referral hospital in northeastern Brazil. Female patients accounted for 62.0% of the study population, consistent with the female predominance (54.4%) reported by Rohr et al. in a retrospective surgical series conducted at a Brazilian public hospital [9]. Female predominance was also observed by Nusz et al. in a population-based study of children with intermittent exotropia, in which girls represented 64.1% of cases [11].

Nearly half of the patients (48.8%) were aged 10 years or younger at the time of surgery. Persistent ocular misalignment during childhood can interfere with binocular visual development and contribute to suppression, amblyopia, and reduced stereopsis [12,13]. In selected conditions, particularly infantile esotropia, earlier ocular alignment may favor binocular sensory development, although outcomes depend on preexisting sensory function and the timing of intervention [12-14]. Beyond visual function, strabismus may affect self-perception, interpersonal relationships, and emotional well-being. During childhood and adolescence, visible ocular misalignment may contribute to teasing, bullying, and reduced quality of life [15,16]. These considerations highlight the importance of addressing both the functional and psychosocial consequences of strabismus during childhood and adolescence.

Horizontal strabismus was the predominant clinical classification, accounting for 76.4% of patients, with esotropia representing 65.4% of horizontal deviations. Horizontal ocular misalignment encompasses a heterogeneous group of conditions with distinct clinical characteristics, underlying mechanisms, and therapeutic considerations [3,17]. Esotropia may occur in association with accommodative factors, abnormalities of binocular sensory development, or acquired disturbances of ocular motor control. Surgical treatment may be indicated when a significant nonaccommodative component persists despite appropriate optical correction or when satisfactory ocular alignment cannot be achieved through nonsurgical management [4]. Mixed strabismus was documented in 19.4% of patients, reflecting the presence of combined horizontal and vertical components in a substantial proportion of the surgical population. Such presentations may require a comprehensive assessment of ocular motility, including associated vertical deviations, incomitance, and extraocular muscle dysfunction, to guide individualized surgical planning [14].

Hyperopia was the most frequently documented refractive category, accounting for 79.3% of the study population. In susceptible children, increased accommodative effort associated with hyperopia may stimulate excessive accommodative convergence and contribute to esodeviation [4,18]. The relationship between refractive error and ocular alignment is particularly relevant in the clinical assessment of patients with esotropia, as the accommodative component may influence treatment decisions. Cycloplegic refractive assessment and appropriate optical correction are therefore essential for identifying accommodative components and distinguishing them from residual nonaccommodative deviations before surgical planning [2,3]. However, because refractive status and strabismus classification were evaluated descriptively, without patient-level analyses of their relationship, the high frequency of hyperopia observed in this cohort cannot be interpreted as evidence of an association between hyperopia and esotropia.

Diplopia and abnormal head posture were documented in 11.2% and 14.0% of patients, respectively. The presence of diplopia in patients with strabismus is influenced by several factors, including the age of onset,

the duration of ocular misalignment, and the development of sensory adaptations. While acquired deviations are more frequently associated with diplopia, patients with childhood-onset strabismus may develop sensory suppression or anomalous retinal correspondence, reducing the perception of double vision [4]. Abnormal head posture represents another important clinical manifestation, particularly in patients with incomitant deviations, in whom compensatory head positioning may help maintain binocular single vision, reduce diplopia, or optimize ocular alignment in specific gaze positions [19]. These manifestations illustrate the functional complexity of strabismus and the importance of considering both motor and sensory characteristics during clinical evaluation and surgical planning.

Ocular comorbidities were documented in 23.6% of patients, including amblyopia, ptosis, and congenital cataract. These conditions are particularly relevant during childhood, when normal visual development depends on adequate retinal image quality, ocular alignment, and binocular sensory integration [2]. Amblyopia represents an important consideration in patients with strabismus, as reduced visual acuity and impaired binocular function may limit the potential for stereopsis and binocular recovery following surgical alignment. Similarly, congenital cataract and visually significant ptosis may interfere with normal visual stimulation during critical periods of visual development, potentially contributing to sensory disturbances and secondary ocular misalignment [20]. The coexistence of these conditions emphasizes the importance of evaluating visual acuity, refractive status, and binocular sensory function when planning strabismus surgery, since achieving ocular alignment does not necessarily imply restoration of normal binocular vision.

Systemic comorbidities were identified in 19.4% of patients, including neurological conditions and thyroid disorders. Neurological diseases may contribute to ocular misalignment through abnormalities involving cranial nerves, supranuclear pathways, or central mechanisms responsible for ocular motor coordination. Depending on the underlying condition, these disturbances may result in incomitant deviations, limitations of ocular movement, or impaired binocular control [21]. Thyroid-associated orbitopathy represents another clinically relevant cause of ocular motility dysfunction, particularly through inflammatory changes and fibrosis of the extraocular muscles, which may produce restrictive strabismus and diplopia. Although thyroid disorders do not necessarily imply orbital involvement, their identification during clinical assessment is important because associated ocular manifestations may influence the evaluation and management of strabismus [22]. These considerations illustrate the need to assess ocular motility in the context of the patient's broader systemic condition, particularly in tertiary referral settings where patients may present with complex clinical histories.

A history of trauma was documented in 9.5% of patients, while a family history of strabismus was reported in 7.9%. Ocular or orbital trauma may contribute to acquired strabismus through direct injury to extraocular muscles, orbital fractures with mechanical restriction, or damage to the cranial nerves responsible for ocular movements. The clinical presentation may vary according to the mechanism and severity of injury, ranging from isolated ocular misalignment to complex incomitant deviations associated with diplopia and abnormal head posture [23]. In contrast, a positive family history highlights the recognized contribution of hereditary susceptibility to certain forms of strabismus, particularly childhood-onset deviations. The development of strabismus is considered multifactorial, involving interactions between genetic predisposition, refractive characteristics, binocular sensory development, and environmental influences [24]. Recognition of these different clinical backgrounds is relevant to understanding the heterogeneity of patients referred for surgical treatment and reinforces the importance of individualized clinical assessment and surgical planning.

The annual number of surgical cases varied during the study period, reaching its lowest value in 2020 (n = 15) and its highest in 2022 (n = 72). The reduction observed in 2020 coincided with the COVID-19 pandemic, during which elective surgical services were disrupted in many healthcare settings [25]. The subsequent increase in surgical volume may have been influenced by the resumption of elective procedures and accumulated surgical demand. However, because institutional service availability and waiting-list data were not evaluated, the factors responsible for these variations cannot be established from the present findings.

Several limitations should be acknowledged. The retrospective design and reliance on medical records may have affected the completeness and consistency of the clinical information. Although data extraction was performed by a single physician, the original clinical evaluations were conducted by different healthcare professionals, potentially introducing variability in the documentation and interpretation of clinical findings. Additionally, specific dioptric thresholds used for refractive classification could not be retrospectively verified, and the characterization of associated ocular motility abnormalities depended on the information available in the medical records. Important clinical and surgical variables, including strabismus etiology, deviation magnitude, surgical techniques, postoperative ocular alignment, and functional outcomes, were not systematically assessed. The descriptive nature of the study also precluded the evaluation of potential associations between clinical characteristics. Furthermore, as this was a single-center study conducted at a tertiary referral hospital, the findings may not be representative of patients treated in other healthcare settings or of the general population with strabismus.

Despite these limitations, this study provides a comprehensive description of the demographic and clinical characteristics of patients undergoing strabismus surgery at a tertiary public hospital in northeastern Brazil. By documenting the distribution of strabismus classifications, refractive characteristics, associated

comorbidities, and relevant clinical histories, the study contributes regional information on the profile of patients receiving surgical treatment within a specialized public healthcare service. These findings may support future multicenter investigations aimed at improving the characterization of surgical populations, exploring factors associated with different strabismus presentations, and evaluating surgical and functional outcomes.

Conclusions

This study provides a comprehensive characterization of patients undergoing strabismus surgery at a tertiary referral hospital in northeastern Brazil. The surgical population included a substantial proportion of children and was characterized by a predominance of horizontal deviations, particularly esotropia, and a high frequency of documented hyperopia. Associated ocular and systemic comorbidities contributed to the clinical heterogeneity of the study population. These findings provide regional data on the characteristics of patients undergoing strabismus surgery within a specialized public healthcare service and may serve as a basis for future multicenter studies incorporating standardized clinical assessments and evaluations of surgical and functional outcomes.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Research Ethics Committee of Hospital Universitário Professor Edgard Santos, Federal University of Bahia (HUPES-UFBA), Brazil issued approval 71066023.4.0000.0049. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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