

Orbital Complications Following Acute Rhinosinusitis in Children: Clinical Outcomes Across Chandler Classification Stages

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Abstract

Purpose

Periorbital and orbital cellulitis represent a spectrum of paediatric infections associated with potentially serious complications. Although widely used, the Chandler classification has limited evidence supporting its role in predicting disease severity and guiding management in children. This study evaluated the clinical utility of the Chandler classification and explored a preliminary risk stratification model for severe disease.

Methods

This retrospective observational cohort study included patients aged under 18 years admitted with periorbital or orbital cellulitis between January 2023 and December 2025. Patients were classified according to Chandler stages I–IV. Demographic, clinical, microbiological, radiological and outcome data were extracted from electronic records. Pearson's chi-square tests and ordinal logistic regression were used to identify associations and independent predictors of severe disease.

Results

Eighty-six patients were included: 87.2% had Chandler stage I disease, 2.3% stage II, 5.8% stage III and 4.7% stage IV. Time from presentation to CT imaging demonstrated the strongest association with Chandler stage ($\chi^2 = 90.78$, $p < 0.001$), followed by surgical management, nasal steroid use and sinus involvement. Ophthalmoplegia and proptosis were strongly associated with advanced disease. In dichotomised analyses comparing mild (stages I–II) and severe disease (stages III–IV), time to CT imaging showed the largest effect size. Exploratory regression analyses identified admission duration as independently associated with increasing Chandler stage, while age and admission duration were independently associated with severe disease in the dichotomised analysis.

Conclusions

The Chandler classification differentiates disease severity in paediatric orbital infections and may support early recognition of patients requiring escalated care.

Introduction

Periorbital (preseptal) cellulitis and orbital cellulitis represent a spectrum of paediatric infections that require prompt diagnosis and management to prevent potentially serious complications, including visual impairment, intracranial extension, and permanent disability ^[1, 2]. They constitute the most common orbital complications of acute rhinosinusitis and remain an important cause of paediatric hospital admission ^[1, 3]. The close anatomical relationship between the paranasal sinuses and orbit, coupled with the thin lamina papyracea and valveless venous drainage system, facilitates the spread of infection from the sino-nasal cavity to orbital structures ^[1]. Consequently, children are particularly susceptible to orbital complications arising from sinonasal infections.

The Chandler classification, first described in 1970, remains the most widely used system for categorising orbital complications of acute sinusitis ^[1]. It stratifies disease severity into five stages ranging from preseptal cellulitis (Stage I) to cavernous sinus thrombosis (Stage V) ^[1]. Owing to its simplicity and widespread clinical acceptance, the classification continues to be used across ophthalmology, otorhinolaryngology, paediatrics, and emergency medicine to communicate

disease severity and guide management decisions [4, 5]. However, the classification was developed before the routine use of modern cross-sectional imaging and contemporary multidisciplinary management strategies, and its utility in predicting clinically relevant outcomes in present-day paediatric practice remains incompletely understood [6, 7].

Advances in computed tomography (CT), magnetic resonance imaging (MRI), endoscopic sinus surgery, antimicrobial therapy, and specialist ophthalmic care have substantially altered the diagnosis and management of orbital infections over the past five decades [7, 8]. Although the Chandler classification remains embedded within contemporary clinical guidelines, relatively few studies have evaluated its performance within modern paediatric populations or examined whether increasing Chandler stage is consistently associated with clinically meaningful outcomes such as visual complications, requirement for surgical intervention, prolonged hospitalisation, and specialist ophthalmology involvement [9, 10].

Management of paediatric periorbital and orbital cellulitis continues to vary between institutions, particularly regarding indications for imaging, timing of specialist referral, and thresholds for surgical intervention [8, 11]. Several national and international guidelines recommend the use of the Chandler classification when assessing disease severity; however, evidence supporting its prognostic value in contemporary practice remains limited [8, 12, 13]. Furthermore, much of the existing literature comprises retrospective single-centre studies with heterogeneous patient populations and inconsistent outcome reporting, limiting the generalisability of their findings [9, 14].

Given the continued reliance on the Chandler classification in clinical practice, there remains a need for contemporary evidence evaluating its association with clinically relevant outcomes in paediatric patients. Improved understanding of how Chandler stage correlates with orbital complications, surgical requirements, and healthcare utilisation may assist clinicians in risk assessment, multidisciplinary decision-making, and resource allocation.

Therefore, the primary aim of this study was to evaluate the clinical utility of the Chandler classification in a contemporary paediatric cohort by assessing associations between disease stage and clinically relevant outcomes, including orbital complications, requirement for surgical intervention, length of hospital stay, and ophthalmology review. Secondary objectives were to examine associations between Chandler stage and clinical, microbiological, and radiological characteristics, and to explore factors associated with increasing disease severity within the Chandler classification framework [15, 16].

Materials and Methods

Study Design and Setting

This retrospective observational cohort study was conducted at a large National Health Service (NHS) organisation serving North Wales, United Kingdom. The study aimed to evaluate the clinical utility of the Chandler classification in paediatric periorbital and orbital cellulitis and to assess the distribution of orbital complications across Chandler stages.

The study was designed and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for observational cohort studies and was critically appraised using the Critical Appraisal Skills Programme (CASP) Cohort Study Checklist to ensure methodological rigour, transparency, and reproducibility [17, 18].

This retrospective observational study was approved by the local Research Ethics Committee (No. 372361) and was conducted in accordance with the principles of the Declaration of Helsinki. As the study involved a retrospective review of anonymized routinely collected clinical data and did not involve direct patient contact or intervention, the requirement for informed consent was waived by the Research Ethics Committee.

Study Population and Case Identification

All consecutive paediatric patients aged less than 18 years admitted to the study institution with a diagnosis of orbital complication with acute rhinosinusitis between 1 January 2023 and 31 December 2025 were eligible for inclusion.

To minimise case ascertainment bias, patients were identified through multiple overlapping sources including electronic health records, ophthalmology referral databases, otorhinolaryngology admission records, radiology reporting systems, discharge coding databases, and International Classification of Diseases Tenth Revision (ICD-10) diagnostic codes.

Diagnostic confirmation was established through documented clinical examination findings, specialist ophthalmological assessment where available, and radiological investigations including contrast-enhanced CT of the orbit and paranasal sinuses when clinically indicated.

Eligibility Criteria

Inclusion Criteria

Patients were included if they

- Were aged less than 18 years
- Were admitted to the study institution during the study period
- Had a documented diagnosis of orbital complication following acute rhinosinusitis
- Had sufficient clinical and radiological information available to permit Chandler classification.

Exclusion Criteria

Patients were excluded if they:

- Had incomplete medical records precluding accurate Chandler classification or outcome assessment
- Were transferred from another institution with unavailable baseline clinical data
- Were immunocompromised
- Had sustained facial or orbital trauma within four weeks prior to presentation
- Had undergone orbital or sino-nasal surgery within four weeks prior to presentation.

These exclusion criteria were selected to minimise information bias and reduce confounding arising from alternative causes of orbital inflammation.

Data Collection

Data were retrospectively extracted from electronic patient records, the Picture Archiving and Communication System (PACS), laboratory information systems, and microbiology databases using a predefined standardised data collection proforma.

Collected variables included demographic characteristics (age and sex), laterality of infection, clinical signs and symptoms (eyelid oedema, erythema, chemosis, fever, proptosis, ophthalmoplegia, and visual impairment), radiological findings (CT imaging, time to CT imaging, sinus involvement, abscess dimensions and volume, and Chandler classification), microbiological findings (blood cultures, eye swab cultures, and isolated organisms), treatment variables (intravenous

antibiotics, oral antibiotics, nasal steroids/decongestants, ophthalmology review, and surgical intervention), and clinical outcomes including length of hospital stay and orbital complications.

To minimise information bias, data extraction procedures were standardised prior to study commencement. A random 10% sample of records underwent independent verification by a second investigator to ensure data accuracy and consistency.

Chandler Classification

Patients were classified according to the Chandler classification system using documented clinical findings and radiological features.

- Stage I (Preseptal Cellulitis) was defined as infection confined anterior to the orbital septum without post-septal involvement.
- Stage II (Orbital Cellulitis) was defined as diffuse inflammatory involvement of orbital tissues posterior to the orbital septum without abscess formation.
- Stage III (Subperiosteal Abscess) was defined as a localised purulent collection between the orbital wall and periosteum.
- Stage IV (Orbital Abscess) was defined as a discrete abscess within the orbital contents.
- Stage V (Cavernous Sinus Thrombosis) was defined as intracranial extension involving the cavernous sinus.

Chandler classification was independently assigned by two investigators using predefined clinical and radiological criteria. Reviewers were blinded to outcome assessment during classification. Discrepancies were resolved through consensus review involving senior ophthalmology and otorhinolaryngology clinicians. Inter-observer agreement was assessed using Cohen's kappa coefficient.

Outcome Measures

Primary Outcome

The primary outcome was the occurrence and distribution of orbital complications according to Chandler classification stage.

Orbital complications were predefined as the presence of one or more of the following:

- Proptosis
- Ophthalmoplegia
- Visual impairment
- Subperiosteal abscess
- Orbital abscess
- Intracranial extension
- Requirement for surgical intervention

Secondary Outcomes

Secondary outcomes included:

- Length of hospital stay

- Time from presentation to CT imaging
- Requirement for ophthalmology specialist review
- Presence of sinus involvement
- Microbiological findings
- Antibiotic treatment patterns

Missing Data

Data completeness was assessed before statistical analysis. Variables with substantial missing data (> 20%) were excluded from comparative analyses. For variables with limited missingness, complete-case analysis was performed. The extent of missing data for each variable was reported in Fig. 1.

Confounding and Bias

Several measures were undertaken to minimise potential sources of bias and confounding inherent in retrospective observational research. Selection bias was reduced through inclusion of all consecutive eligible admissions during the study period using predefined inclusion and exclusion criteria. Information bias was minimised through the use of a standardised data extraction proforma and the utilisation of multiple independent data sources, including electronic health records, radiology archives, microbiology databases, and specialist referral records.

Misclassification bias relating to Chandler staging was addressed through independent assessment by two investigators using predefined classification criteria, with disagreements resolved through multidisciplinary consensus review. Inter-observer agreement was formally assessed using Cohen's kappa coefficient.

Potential confounding variables including age, sex, presenting clinical features, microbiological findings, and radiological evidence of sinus involvement were systematically collected and evaluated during the analysis. As the primary objective was descriptive and comparative rather than predictive, confounding was primarily addressed through stratified analyses across Chandler stages rather than extensive multivariable modelling.

Detection bias may have arisen because CT imaging was performed according to clinical indication rather than a standardised protocol, potentially increasing the likelihood of identifying orbital complications in clinically severe cases. Residual confounding from unmeasured variables, including duration of symptoms prior to presentation, previous antibiotic exposure, referral delays, and clinician-specific management decisions, cannot be entirely excluded.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA) and R version 4.3.1 (R Foundation for Statistical Computing, Vienna, Austria).

Continuous variables were assessed for normality using the Shapiro–Wilk test. Normally distributed variables were reported as mean $\pm$ standard deviation (SD), whereas non-normally distributed variables were summarised as median and interquartile range (IQR). Categorical variables were presented as frequencies and percentages.

Associations between Chandler classification stage and categorical demographic, clinical, microbiological, radiological, and treatment variables were evaluated using Pearson's chi-square test of independence. Where expected cell counts were fewer than five, Fisher's exact test was applied as appropriate. The strength of association was quantified using Cramer's V and interpreted as small (0.10–0.29), moderate (0.30–0.49), and large (≥ 0.50) effect sizes.

For continuous variables demonstrating non-normal distributions, including abscess volume, ordered trends across Chandler stages were assessed using the Jonckheere–Terpstra test. Median values and distributional characteristics were

examined to evaluate progressive changes across increasing disease severity categories. Following bivariate analyses, an exploratory ordinal logistic regression model was constructed to examine factors associated with increasing Chandler stage severity. An initial full model incorporating demographic, clinical, radiological, microbiological, and treatment-related variables was evaluated. Owing to sparse observations within several predictor categories and marked imbalance across Chandler stages, the full model demonstrated instability characterised by large standard errors and evidence of complete or quasi-complete separation.

Consequently, a variable reduction strategy was undertaken based on data sparsity, variance inflation factor assessment, clinical plausibility, and model convergence. A parsimonious ordinal logistic regression model was subsequently fitted using variables that demonstrated adequate representation and acceptable multicollinearity profiles. Regression coefficients (β), standard errors, odds ratios (ORs), 95% confidence intervals (CIs), and p-values were reported.

The proportional odds assumption was formally assessed prior to interpretation. Although this assumption was not fully satisfied, the ordinal framework was retained as an exploratory analysis to evaluate overall associations with increasing Chandler severity. Findings from regression modelling were considered hypothesis-generating and interpreted cautiously owing to the limited number of advanced-stage cases.

Inter-observer reliability for Chandler classification was assessed using Cohen’s kappa coefficient.

All statistical tests were two-sided, and a p-value < 0.05 was considered statistically significant throughout.

Results

Classification of Paediatric Patients According to Chandler Classification

The cohort (n = 86) was predominantly composed of patients with mild disease, with only 9 patients (10.5%) demonstrating advanced disease (Chandler Stages III–IV). The distribution is summarised in Table 1.

Table 1
Distribution of Patients According to Chandler Classification

Chandler Classification	N	%
Stage I - Preseptal cellulitis	75	87.2
Stage II - Orbital cellulitis	2	2.3
Stage III - Subperiosteal abscess	5	5.8
Stage IV - Orbital abscess	4	4.7
Total	86	100.0

Data are presented as n (%).

Demographic, Clinical, Microbiological, and Radiological Characteristics and Their Association With Chandler Classification

A total of 86 paediatric patients were included in the study. Baseline demographic, clinical, radiological, microbiological and management characteristics stratified according to Chandler classification are presented in Table 2.

Table 2
Demographic, Clinical, Radiological, and Management Characteristics According to Chandler Classification

Factor	Stage I Preseptal Cellulitis (n = 75)	Stage II Orbital Cellulitis (n = 2)	Stage III Subperiosteal Abscess (n = 5)	Stage IV Orbital Abscess (n = 4)	Total (n = 86)	p-value	χ^2	Cramer's V (Effect Size)
Sex						0.436	2.727	0.178
Female	34 (45.3%)	0 (0.0%)	3 (60.0%)	1 (25.0%)	38			
Male	41 (54.7%)	2 (100.0%)	2 (40.0%)	3 (75.0%)	48			
Laterality						0.889	2.312	0.116
Right	40 (53.3%)	2 (100.0%)	3 (60.0%)	2 (50.0%)	47			
Left	31 (41.3%)	0 (0.0%)	2 (40.0%)	2 (50.0%)	35			
Bilateral	4 (5.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4			
Clinical Features								
Chemosis	16 (21.3%)	1 (50.0%)	3 (60.0%)	2 (50.0%)	22	0.127	0.148	0.042
Fever	11 (14.7%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	12	0.315	3.545	0.203
Proptosis	2 (2.7%)	0 (0.0%)	2 (40.0%)	3 (75.0%)	7	< 0.001	33.885	0.628
Ophthalmoplegia	0 (0.0%)	0 (0.0%)	2 (40.0%)	2 (50.0%)	4	< 0.001	50.390	0.765
Visual impairment	2 (2.7%)	0 (0.0%)	0 (0.0%)	1 (25.0%)	3	0.246	4.148	0.220
Investigations								
CT imaging performed	4 (5.3%)	1 (50.0%)	5 (100.0%)	4 (100.0%)	14	< 0.001	90.783	0.593
Sinus involvement	4 (5.3%)	1 (50.0%)	4 (80.0%)	3 (75.0%)	12	0.006	18.288	0.345
Eye swab performed	26 (34.7%)	1 (50.0%)	2 (40.0%)	2 (50.0%)	31	0.896	0.603	0.084
Blood culture performed	31 (41.3%)	2 (100.0%)	3 (60.0%)	4 (100.0%)	40	0.382	9.622	0.193
Management								
Nasal steroids/decongestants	12 (16.0%)	1 (50.0%)	4 (80.0%)	3 (75.0%)	20	0.002	20.442	0.357
Surgical intervention	1 (1.3%)	0 (0.0%)	2 (40.0%)	3 (75.0%)	6*	< 0.001	19.523	0.488

Data are presented as n (%). Percentages are calculated within Chandler classification stages. p-values were derived using Pearson's chi-square test or Fisher's exact test where appropriate. Effect size was assessed using Cramer's V. n: number; CT:

computed tomography; χ^2 : chi-square; p -value < 0.05 is considered significant.

The median duration of hospital admission for the entire cohort was 2 days (IQR: 1–3). Volume of Abscess was nil for 73(85%). 80(93%) did not require surgical management. Infants (< 1 year) predominantly fell into stage 1, whereas older children shifted towards a higher category.

Among patients with radiologically confirmed sinus involvement ($n = 12$), involvement of all four paranasal sinuses was the most common pattern ($n = 4$), followed by combined maxillary and ethmoidal sinus disease ($n = 4$). Isolated maxillary sinus involvement was identified in two patients, isolated ethmoidal sinus involvement in one patient, and combined maxillary, ethmoidal and sphenoidal sinus disease in one patient.

Eye swabs were obtained in 31 patients (36.0%), whereas blood cultures were performed in 40 patients (46.5%). *Haemophilus influenzae* was the most frequently isolated organism from eye swab cultures ($n = 7$), followed by *Streptococcus pneumoniae* ($n = 3$), *Staphylococcus aureus* ($n = 2$), and *Streptococcus sanguinis* ($n = 2$). Single isolates of *Moraxella* species, *Neisseria* species, and *Chlamydia* species were also identified. No organism was cultured in 15 eye swab specimens. Blood cultures were predominantly negative, with only one positive culture yielding a pathogenic organism and two cultures reported as contaminants.

The majority of patients ($n = 80$, 93.0%) were managed conservatively with medical therapy alone. Oral co-amoxiclav (amoxicillin/clavulanic acid) was the most commonly prescribed antibiotic ($n = 75$, 87.2%), with intravenous ceftriaxone used in 18 patients (20.9%) and intravenous metronidazole in 22 patients (25.6%) as adjunctive therapy.

Bivariate analyses demonstrated significant associations between Chandler classification severity and several clinical and radiological variables. The strongest association was observed for time from presentation to computed tomography (CT) imaging ($\chi^2=90.783$, $p < 0.001$, Cramer's $V = 0.593$). Significant associations were also identified for ophthalmoplegia ($\chi^2=50.390$, $p < 0.001$, Cramer's $V = 0.765$), proptosis ($\chi^2=33.885$, $p < 0.001$, Cramer's $V = 0.628$), surgical intervention ($\chi^2=19.523$, $p < 0.001$, Cramer's $V = 0.488$), use of nasal steroids or decongestants ($\chi^2=20.442$, $p = 0.002$, Cramer's $V = 0.357$), and radiologically confirmed sinus involvement ($\chi^2=18.288$, $p = 0.006$, Cramer's $V = 0.345$).

Abscess Volume

Abscess volume according to Chandler classification is presented in Table 3 and illustrated in Fig. 2. As abscess volume was non-normally distributed, a Jonckheere–Terpstra test was performed to assess for an ordered trend across increasing Chandler stages. Median abscess volume increased progressively with disease severity, from 0.00 mm³ in Stage I disease to 270.56 mm³ in Stage II, 691.65 mm³ in Stage III, and 929.00 mm³ in Stage IV. Although both Table 3 and Fig. 2 demonstrate an increase in abscess burden with advancing Chandler classification, the observed trend did not reach statistical significance ($J = 25$, $p = 0.308$).

Table 3
Abscess Volume Measurements According to Chandler Classification Stage

Chandler Classification	N	Mean Volume (mm ³)	Standard Error	95% CI Lower	95% CI Upper	Median Volume (mm ³)	Minimum	Maximum
Stage I – Preseptal Cellulitis	75	195.44	168.93	-141.16	532.04	0.00	0.00	12600.00
Stage II – Orbital Cellulitis	2	270.56	270.56	-3167.23	3708.35	270.56	0.00	541.12
Stage III – Subperiosteal Abscess	5	1508.94	1075.71	-1477.72	4495.60	691.65	19.50	5775.00
Stage IV – Orbital Abscess	4	1728.63	1058.26	-1639.23	5096.48	929.00	256.50	4800.00
Total	86	344.86	169.99	6.88	682.85	0.00	0.00	12600.00

An increasing trend in abscess volume was observed with advancing disease severity; however, the association was not statistically significant (Jonckheere–Terpstra test, $J = 25$, $p = 0.308$).

Exploratory Multivariable Ordinal Regression Analysis

An exploratory multivariable ordinal logistic regression analysis was performed to identify factors associated with increasing Chandler classification severity. Duration of hospital admission was independently associated with higher Chandler stage (OR 1.86, 95% CI 1.25–2.75; $p = 0.002$). Age demonstrated a positive association with increasing disease severity but did not reach statistical significance (OR 1.16, 95% CI 0.99–1.36; $p = 0.070$) (Table 4).

The proportional odds assumption was violated; therefore, these findings should be interpreted as exploratory and hypothesis-generating.

The results of the final ordinal regression model are presented in Table 4.

Table 4
Final Ordinal Logistic Regression Model for Chandler Classification Severity

Predictor	beta (SE)	z	p-value	OR (95% CI)
Duration of admission (days)	0.6186 (0.200)	3.096	0.002	1.86 (1.25–2.75)
Age at presentation (years)	0.1496 (0.083)	1.813	0.070	1.16 (0.99–1.36)
Threshold (Stage I/II)	4.8665 (1.201)	4.051	< 0.001	-

OR, odds ratio; CI, confidence interval; SE, standard error. The proportional odds assumption was violated ($p < 0.05$); the model was retained as a conservative exploratory estimate.

Exploratory Multivariable Analysis of Severe Disease

An exploratory multivariable logistic regression analysis was performed following dichotomisation of disease severity into mild (Chandler Stages I–II) and severe disease (Chandler Stages III–IV). Following variable reduction, the final model retained age at presentation and duration of hospital admission as factors independently associated with severe disease. Duration of admission was associated with higher odds of severe disease ($\beta = 0.657$, SE = 0.215, OR 1.93, 95% CI 1.27–2.93; $p = 0.002$). Increasing age was also associated with severe disease ($\beta = 0.257$, SE = 0.107, OR 1.29, 95% CI 1.05–1.60; $p = 0.016$) (Table 5).

Given the limited number of severe cases and the retrospective nature of the study, these findings should be interpreted as exploratory and hypothesis-generating rather than confirmatory. These results are presented in Table 5.

Table 5
Final Logistic Regression Model for Dichotomised Disease Severity

Predictor	beta (SE)	z	p-value	OR (95% CI)
Duration of admission (days)	0.6573 (0.215)	3.063	0.002	1.93 (1.27–2.93)
Age at presentation (years)	0.2565 (0.107)	2.407	0.016	1.29 (1.05–1.60)
Threshold (Mild/Severe)	6.3584 (1.627)	3.908	< 0.001	-

OR, odds ratio; CI, confidence interval; SE, standard error.

Discussion

This retrospective cohort study evaluated the utility of the Chandler classification in assessing disease severity among children presenting with orbital complications following acute rhinosinusitis. The findings demonstrate that the Chandler classification remains clinically relevant, with significant associations observed between increasing disease severity and key clinical, radiological, and management-related variables. In particular, ophthalmoplegia, proptosis, sinus involvement, CT imaging, and surgical intervention were strongly associated with advanced Chandler stages.

The distribution of Chandler stages observed in this cohort is consistent with previous reports, with most patients presenting with Stage I disease and only a small proportion developing advanced orbital complications. No cases of cavernous sinus thrombosis were identified, reflecting the rarity of this complication in the modern antibiotic era and the benefits of early recognition and treatment [19, 20]. These findings support the continued use of the Chandler classification as a practical framework for stratifying disease severity in contemporary paediatric practice [1, 6].

Among all clinical variables examined, ophthalmoplegia and proptosis demonstrated the strongest associations with increasing Chandler severity. Ophthalmoplegia exhibited the largest effect size of any variable analysed, highlighting its importance as a marker of post-septal involvement. This finding is consistent with the pathophysiology of orbital infection, whereby inflammation and compression of orbital tissues impair extraocular muscle function [21, 22]. Similarly, proptosis demonstrated a strong association with advanced disease, reflecting increasing orbital pressure secondary to inflammatory oedema or abscess formation [23–26]. These findings reinforce the importance of careful orbital examination in children presenting with periorbital swelling and support existing recommendations that the presence of ophthalmoplegia or proptosis should prompt urgent specialist review and radiological assessment [9, 27].

In contrast, more generalised clinical features such as fever, chemosis, and visual impairment were not significantly associated with Chandler stage. Whilst these signs remain important components of the clinical assessment, they appear to have limited discriminatory value in distinguishing between mild and severe disease when considered independently.

Radiologically confirmed sinus involvement was significantly associated with increasing Chandler severity, supporting the established role of acute rhinosinusitis in the pathogenesis of orbital complications [1, 28, 29]. Multi-sinus disease was frequently observed among patients with advanced disease, reflecting the close anatomical relationship between the paranasal sinuses and the orbit. Furthermore, the strong association between disease severity and CT imaging emphasises the importance of timely radiological evaluation when orbital involvement is suspected and supports current recommendations advocating selective imaging in patients with suspected post-septal disease [9, 30, 31].

The microbiological profile observed in this cohort was broadly consistent with existing literature, with *Haemophilus influenzae*, *Streptococcus pneumoniae*, and *Staphylococcus aureus* representing the most frequently isolated organisms [3,

4, 12]. The low yield of blood cultures observed in this study is also consistent with previous reports and suggests that bloodstream infection is uncommon in otherwise uncomplicated disease [3, 9].

Abscess volume increased progressively across Chandler stages, although this trend did not achieve statistical significance. Nevertheless, the observed increase in abscess burden with advancing disease severity provides further support for the biological validity of the Chandler classification as a marker of increasing disease burden.

Exploratory multivariable analyses identified increasing age and longer duration of hospital admission as factors associated with severe disease. However, these findings should be interpreted cautiously given the limited number of severe cases and the retrospective nature of the study. Larger prospective multicentre studies are required to determine whether these associations are reproducible and whether they may contribute to future prognostic models for orbital complications following acute rhinosinusitis [13, 14].

Strengths and Limitations

This study possesses several methodological strengths. The use of a standardised data extraction proforma, comprehensive collection of clinical, radiological, and outcome variables, and rigorous statistical analysis incorporating effect size measures and multivariable modelling enhance the reliability of the findings. The study was designed and reported in accordance with STROBE and CASP guidelines, facilitating critical appraisal and potential inclusion in future systematic reviews [17, 18]. The contemporary cohort (2023–2025) ensures relevance to current clinical practice and antibiotic prescribing patterns.

Several limitations must be acknowledged. The retrospective single-centre design introduces potential for selection bias, information bias, and limited generalisability. The sample size of 86 patients, whilst representative of the epidemiology at a single institution over a three-year period, resulted in small numbers in advanced Chandler stages, constraining the power of statistical analyses and preventing the development of a more comprehensive multi-parameter risk model. The high proportional imbalance between mild and severe disease (89.5% versus 10.5%) necessitated strict variable reduction, limiting the complexity of the final model. The violation of the proportional odds assumption in ordinal regression, whilst addressed through retention of the ordinal framework as a conservative estimate, may have introduced some bias in threshold-specific estimates. No external validation cohort was available to assess model performance in an independent population, and the preliminary risk score could not be derived due to the distributional imbalance.

Furthermore, the retrospective nature precluded standardised assessment of clinical signs, and the decision to obtain CT imaging was at the discretion of the treating clinician rather than protocol-driven, potentially introducing detection bias. The study period (2023–2025) coincided with evolving patterns of antibiotic resistance and changing paediatric infectious disease epidemiology, which may affect the generalisability of the microbiological findings. Finally, longer-term outcomes such as visual function, recurrence rates, and quality of life were not captured in this study and represent important areas for future investigation.

To conclude, this study provides contemporary evidence supporting the clinical utility of the Chandler classification in differentiating disease severity in paediatric periorbital and orbital cellulitis. Time to CT imaging, ophthalmoplegia, and proptosis emerged as the strongest discriminators of severe disease, whilst exploratory multivariable analyses identified age at presentation and duration of hospital admission as factors associated with severe disease. These findings may inform the development of standardised risk stratification pathways and support clinical decision-making regarding the urgency of imaging, specialist referral, and potential surgical intervention. Prospective multi-centre validation of the preliminary risk model, incorporating a larger and more balanced cohort, is warranted to confirm these findings and facilitate the derivation of a clinically applicable severity score for paediatric periorbital and orbital cellulitis.

Declarations

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Author Contribution

SS: Conceptualization, data curation, investigation, writing—original draft, and writing—review and editing. AA: Conceptualization, methodology, Data acquisition, formal analysis, investigation, data curation, Tables and Figures, writing—original draft, and writing—review and editing. SR: Methodology, data interpretation, investigation, and writing—review and editing, supervision, interpretation of results, critical revision of the manuscript, and overall responsibility for the work. RA: Tables, methodology, writing—review and editing. All authors contributed to the study, approved the final version of the manuscript, and agree to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. SS & AA are to be considered as co-first authors.

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Data Availability

The datasets generated and/or analysed during the current study are not publicly available due to patient privacy and confidentiality considerations but are available from the corresponding author on reasonable request, subject to appropriate ethical and institutional approvals.

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Figures

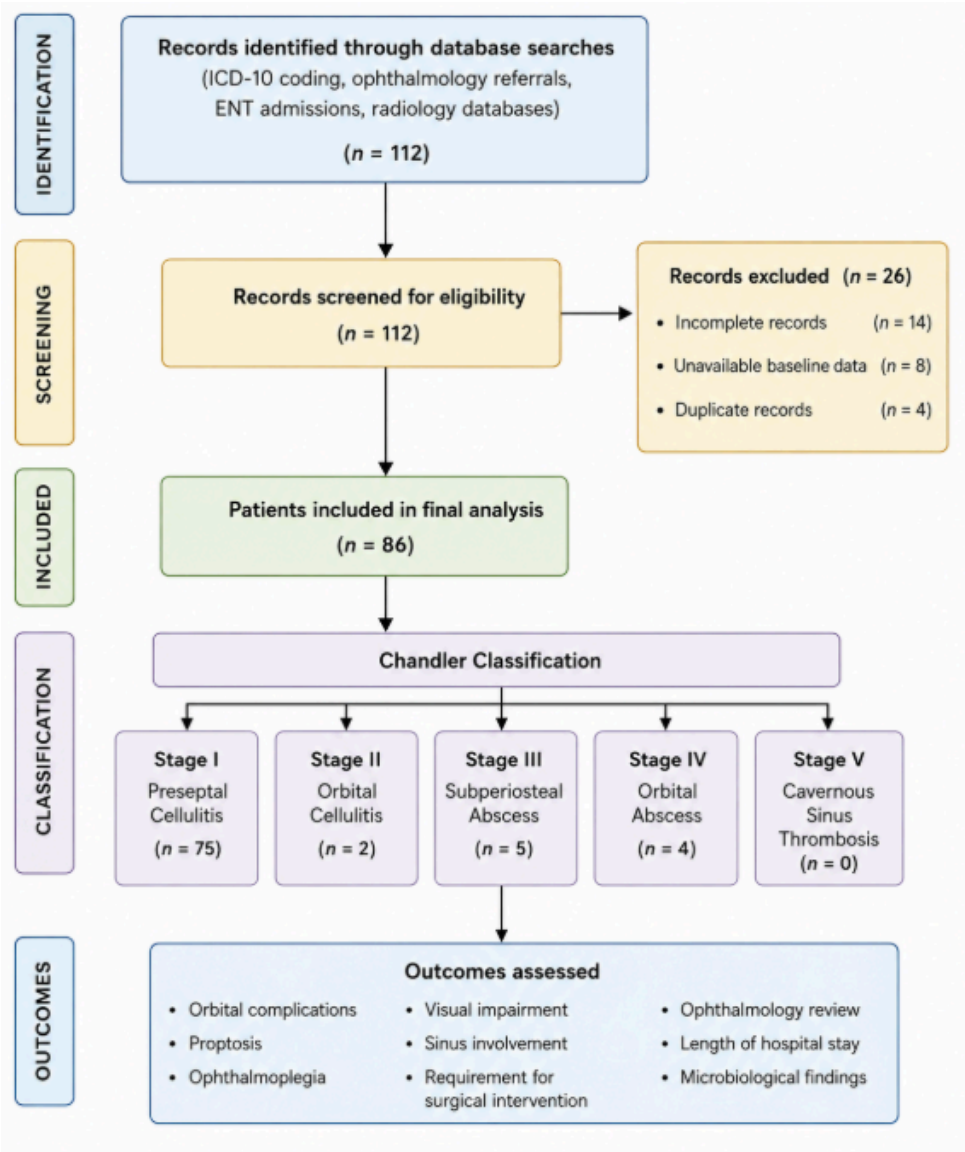


Figure 1

Flow diagram illustrating patient identification, eligibility assessment, exclusion criteria, and final cohort allocation according to Chandler classification. Consecutive paediatric patients admitted with periorbital or orbital cellulitis between January 2023 and December 2025 were screened for inclusion. Eighty-six patients met eligibility criteria and were included in the final analysis.

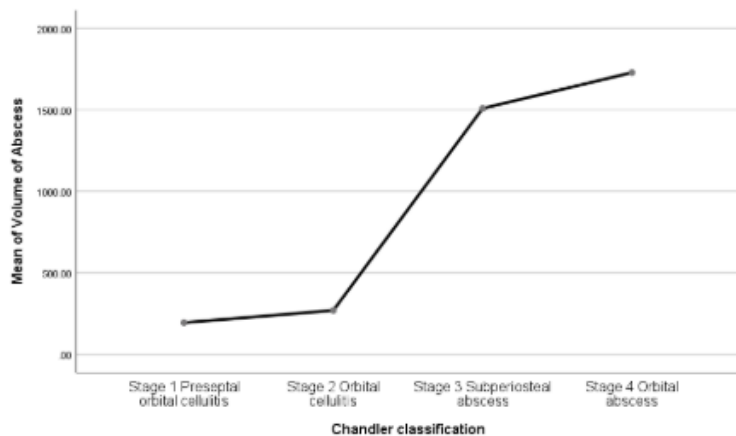


Figure 2

Progressive increase in mean abscess volume across Chandler classification stages, with the largest volumes observed in patients with Stage III and Stage IV disease.