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ORIGINAL ARTICLE

Comparative Study of CT vs MRI in Evaluation of Orbital Cellulitis and Its Complications

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ABSTRACT:
Background: Orbital cellulitis is a potentially vision- and life-threatening infection involving the tissues posterior to the orbital septum. Prompt diagnosis and accurate delineation of disease extent are essential to prevent serious complications such as orbital abscess, cavernous sinus thrombosis, and intracranial spread. Imaging plays a pivotal role in diagnosis, staging, and management. Computed tomography (CT) is commonly used as the initial imaging modality, while magnetic resonance imaging (MRI) offers superior soft-tissue characterization. However, the relative diagnostic performance of CT and MRI in routine tertiary care settings requires further evaluation. **Aim:**To compare the diagnostic efficacy of CT and MRI in the evaluation of orbital cellulitis and its associated complications in patients presenting to a tertiary care hospital. **Materials and Methods:**This hospital-based comparative observational study included 78 clinically suspected cases of orbital cellulitis. All patients underwent both CT and MRI examinations of the orbit using standardized imaging protocols. CT and MRI findings were independently assessed for preseptal and postseptal involvement, extraocular muscle enlargement, optic nerve involvement, abscess formation, sinus disease, bony erosion, cavernous sinus thrombosis, and intracranial extension. Imaging findings were correlated with a composite reference standard based on clinical, laboratory, surgical, and follow-up data. Diagnostic performance parameters including sensitivity, specificity, predictive values, and accuracy were calculated and statistically analyzed. **Results:**MRI demonstrated significantly higher detection rates for postseptal involvement (71.79% vs. 61.54%), extraocular muscle enlargement (66.67% vs. 53.85%), and optic nerve involvement (33.33% vs. 17.95%) compared to CT ($p < 0.05$). MRI was also superior in identifying complications such as subperiosteal abscess, orbital abscess, cavernous sinus thrombosis, and intracranial extension. CT and MRI showed comparable performance in detecting sinus disease and bony erosion. Overall diagnostic accuracy was significantly higher for MRI (89.74%) than CT (79.49%) ($p = 0.018$). **Conclusion:**MRI is superior to CT in evaluating postseptal disease and detecting orbital and intracranial complications of orbital cellulitis, while CT remains valuable for initial assessment and bony evaluation. A tailored imaging approach using CT as the first-line modality and MRI for complex or suspected complicated cases can optimize diagnostic accuracy and patient management.
Keywords: Orbital cellulitis; Computed tomography; Magnetic resonance imaging; Orbital complications; Diagnostic accuracy

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INTRODUCTION

Orbital cellulitis is an acute, potentially vision- and life-threatening infection involving the orbital tissues posterior to the orbital septum. The orbit is a compact anatomical compartment containing the globe, optic nerve, extraocular muscles, and major vascular structures; therefore, inflammatory edema and purulent collections can rapidly increase intraorbital pressure and compromise ocular perfusion and optic nerve function, resulting in irreversible visual loss if not promptly recognized and treated.The most common etiologic pathway is contiguous spread from acute bacterial rhinosinusitis—especially ethmoid sinusitis—through the thin medial orbital wall (lamina papyracea), congenital or acquired bony dehiscence, and valveless venous channels. This anatomical proximity explains why orbital cellulitis commonly coexists with sinonasal disease and why imaging evaluation must routinely include the paranasal sinuses in addition to the orbit.[1] The clinical burden is significant because delayed diagnosis or underestimation of disease extent can allow progression from diffuse cellulitis to focal abscess and intracranial or vascular complications. Consequently, early stratification of disease severity and rapid identification of complications are central goals of assessment.Clinically, patients may present with periorbital swelling, eyelid erythema, pain, fever, chemosis, ophthalmoplegia, proptosis, and visual impairment. However, clinical differentiation between preseptal cellulitis (anterior to the septum) and postseptal/orbital cellulitis is sometimes difficult—particularly in children with marked lid edema, patients with limited cooperation, or those who have already received antibiotics that modify systemic signs.[1] Importantly, orbital cellulitis can occasionally present with limited local signs yet still harbor deeper orbital involvement or complications. Because of these diagnostic uncertainties, imaging plays a decisive role when “red-flag” features are present (restricted ocular movements, proptosis, decreased visual acuity or color vision, afferent pupillary defect, severe pain, or neurological symptoms), or when clinical improvement does not occur with initial therapy.A major clinical concern in orbital cellulitis is development of suppurative collections, particularly subperiosteal abscess and orbital abscess. Subperiosteal abscess arises when purulent material accumulates between the periorbita and the orbital wall, often secondary to adjacent ethmoid sinus infection. This complication can displace orbital contents, worsen proptosis and ophthalmoplegia, and may compromise vision through orbital compartment pressure effects. Management decisions—medical therapy alone versus surgical drainage—depend on multiple factors including clinical severity, visual function, abscess location, and radiologic size/characterization.[2,3] Similarly, orbital abscess represents frank purulence within orbital tissues and is associated with a higher risk of visual loss and intracranial spread; accurate imaging identification and mapping of such collections is therefore essential for timely intervention.Beyond local orbital complications, orbital cellulitis may extend to the cavernous sinus, meninges, or brain, resulting in cavernous sinus thrombosis, meningitis, epidural/subdural empyema, cerebritis, or brain abscess. These complications are uncommon but carry high morbidity and mortality, and their early detection may alter antimicrobial selection, prompt anticoagulation where indicated, and necessitate urgent neurosurgical or ENT procedures. Imaging is therefore not only confirmatory but also prognostic and management-directing, especially in tertiary referral centers where complicated disease presentations are more frequent.Computed tomography (CT) has traditionally been the first-line imaging modality for suspected orbital cellulitis because it is fast, widely available, and provides excellent assessment of paranasal sinus disease and osseous anatomy. CT can demonstrate preseptal thickening, postseptal fat stranding, extraocular muscle enlargement, rim-enhancing abscesses, sinus opacification, air-fluid levels, and bony erosions. It is also practical in emergency settings and in patients with limited ability to cooperate.[4] However, CT has recognized limitations in soft-tissue contrast resolution, which may reduce confidence in differentiating cellulitis/phlegmon from small or early abscess, and in detecting subtle optic nerve involvement, intracranial extension, or venous sinus thrombosis without dedicated protocols. Radiation exposure is an additional concern in pediatric populations and in patients requiring repeat imaging.Magnetic resonance imaging (MRI) offers superior soft-tissue contrast, multiplanar imaging, and enhanced depiction of orbital apex structures, optic nerve, cavernous sinus, meninges, and brain parenchyma. MRI is particularly valuable when complications are suspected or CT findings are equivocal. Advanced sequences such as diffusion-weighted imaging can increase confidence in identifying pus-containing collections due to diffusion restriction, improving differentiation between abscess and non-suppurative inflammation.[5] Additionally, MRI can better evaluate cavernous sinus involvement and subtle intracranial inflammatory change, which may be occult or under-characterized on CT. Nonetheless, MRI is less readily accessible in some emergency pathways, may require longer acquisition times, and can be limited by motion artifacts or contraindications in selected patients.Given these complementary strengths and weaknesses, a persistent clinical question remains: when is CT sufficient for comprehensive evaluation, and when does MRI provide clinically meaningful incremental information that justifies its use? Contemporary clinical work has attempted to refine imaging selection by identifying predictors of abscess and intracranial spread among patients presenting with periorbital/orbital infection, with the aim of improving diagnostic yield while reducing unnecessary radiation exposure.[6] In parallel, evolving management approaches for pediatric orbital cellulitis and subperiosteal abscess highlight the importance of accurate imaging characterization to guide medical versus surgical decision-making.[7]

MATERIALS AND METHODS

This was a hospital-based comparative observational study conducted at a tertiary care referral hospital. The study was designed to evaluate and compare the diagnostic performance of computed tomography (CT) and magnetic resonance imaging (MRI) in the assessment of orbital cellulitis and its associated complications. All imaging examinations were performed within the radiology department using standardized imaging protocols, and findings were interpreted in correlation with clinical and laboratory data.A total of 78 patients clinically suspected of having orbital cellulitis were included in the study. Patients of all age groups and both genders presenting with clinical features suggestive of orbital cellulitis, such as periorbital swelling, pain, fever, restricted ocular movements, proptosis, or visual disturbances, were evaluated. All patients underwent both CT and MRI examinations of the orbit as part of their diagnostic work-up.

Inclusion Criteria

Patients with clinical suspicion of orbital cellulitis who were referred for radiological evaluation and underwent both CT and MRI of the orbit were included. Patients with imaging findings suggestive of preseptal cellulitis, orbital cellulitis, subperiosteal abscess, orbital abscess, cavernous sinus thrombosis, or intracranial extension were considered eligible for inclusion.

Exclusion Criteria
Patients with a history of orbital trauma, previous orbital surgery, known orbital malignancy, or contraindications to MRI such as non-compatible metallic implants or pacemakers were excluded. Patients with incomplete imaging data or poor-quality images limiting diagnostic interpretation were also excluded from the study.

Imaging Technique – Computed Tomography
CT examination of the orbit was performed using a multidetector CT scanner. Axial and coronal sections were obtained with thin slice thickness, covering the orbits, paranasal sinuses, and adjacent intracranial structures. Both non-contrast and contrast-enhanced scans were acquired wherever clinically indicated. CT images were evaluated for preseptal and postseptal involvement, orbital fat stranding, extraocular muscle enlargement, presence and extent of abscess formation, sinus disease, bony erosion, and intracranial complications.

Imaging Technique – Magnetic Resonance Imaging
MRI of the orbit was performed using a high-field strength scanner with a dedicated head and orbit coil. Imaging sequences included axial and coronal T1-weighted, T2-weighted, fat-suppressed sequences, diffusion-weighted imaging (DWI), and post-contrast T1-weighted fat-suppressed sequences. MRI was assessed for soft tissue involvement, optic nerve changes, muscle edema, abscess characterization, diffusion restriction, cavernous sinus involvement, intracranial extension, and vascular complications.

Image Interpretation and Parameters Evaluated
CT and MRI images were independently analyzed by experienced radiologists blinded to each other's findings. Imaging parameters evaluated included the extent of orbital involvement, involvement of preseptal and postseptal compartments, extraocular muscle enlargement, optic nerve involvement, presence and type of abscess (subperiosteal or orbital), sinus involvement, bony changes, cavernous sinus thrombosis, and intracranial spread. The ability of CT and MRI to detect complications and delineate disease extent was systematically compared.

Reference Standard
Final diagnosis and assessment of complications were established based on a composite reference standard including clinical findings, laboratory results, surgical findings where available, and follow-up imaging. Imaging findings from CT and MRI were correlated with this reference standard to assess diagnostic accuracy.

Statistical Analysis
Data were entered and analyzed using appropriate statistical software. Descriptive statistics were used to summarize patient demographics and imaging findings. The diagnostic performance of CT and MRI was compared using sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy. Agreement between CT and MRI findings was assessed using appropriate statistical tests, and a p-value of less than 0.05 was considered statistically significant.

RESULTS

Demographic Characteristics of the Study Population
The demographic distribution of the study population is summarized in Table 1. A total of 78 patients clinically suspected of orbital cellulitis were evaluated. Male patients constituted a higher proportion of the study population, accounting for 56.41%, while females comprised 43.59%. This male predominance suggests a slightly higher occurrence of orbital cellulitis among males in the present study. Age-wise analysis revealed that orbital cellulitis was most commonly observed in the 21–40 years age group (28.21%), followed by patients aged ≤10 years (23.08%). The disease was less frequently encountered in elderly patients above 60 years of age (10.26%).

Clinical Presentation of Orbital Cellulitis
The clinical features observed among the patients are detailed in Table 2. Periorbital swelling was the most frequently reported symptom, present in 92.31% of patients, highlighting it as a hallmark feature of orbital cellulitis. Pain was reported by 82.05% of patients, and fever was observed in 74.36%, indicating an active infectious and inflammatory process. Restricted ocular movements were noted in 58.97% of cases, reflecting postseptal involvement and orbital tissue inflammation. Proptosis was present in 43.59% of patients, while visual disturbances were observed in 28.21%, suggesting optic nerve or posterior orbital involvement in a subset of patients.

Comparison of CT and MRI Findings in Orbital Involvement
Table 3 compares the ability of CT and MRI to detect various imaging features of orbital cellulitis. Both CT and MRI demonstrated comparable detection rates for preseptal involvement and sinus disease, with no statistically significant difference between the two modalities ($p > 0.05$). However, MRI detected postseptal involvement in a significantly higher number of patients (71.79%) compared to CT (61.54%), with a statistically significant difference ($p = 0.046$). Similarly, MRI was significantly superior in identifying extraocular muscle enlargement (66.67% vs. 53.85%, $p = 0.031$) and optic nerve involvement (33.33% vs. 17.95%, $p = 0.012$).

Detection of Orbital and Intracranial Complications

The detection of complications by CT and MRI is presented in Table 4. MRI identified a higher number of subperiosteal abscesses (30.77%) compared to CT (23.08%), with a statistically significant difference ($p = 0.041$). Orbital abscesses were also more frequently detected on MRI (20.51%) than on CT (12.82%), and this difference was statistically significant ($p = 0.039$). MRI demonstrated a marked advantage in detecting cavernous sinus thrombosis and intracranial extension, identifying significantly more cases than CT ($p < 0.05$). In contrast, CT and MRI showed comparable detection rates for bony erosion, with no statistically significant difference ($p = 0.637$).

Diagnostic Performance of CT and MRI

The diagnostic performance of CT and MRI using the composite reference standard is summarized in Table 5. CT demonstrated a sensitivity of 76.92% and specificity of 82.35%, with an overall diagnostic accuracy of 79.49%. MRI showed higher sensitivity (91.03%) and specificity (88.24%) compared to CT, along with superior positive and negative predictive values. The overall diagnostic accuracy of MRI was 89.74%, which was significantly higher than that of CT ($p = 0.018$).

Table 1: Demographic Distribution of Study Population (n = 78)

Variable	Number of Patients	Percentage (%)
Gender		
Male	44	56.41
Female	34	43.59
Age Group (years)		
≤ 10	18	23.08
11–20	14	17.95
21–40	22	28.21
41–60	16	20.51
> 60	8	10.26

Table 2: Clinical Presentation of Patients with Orbital Cellulitis (n = 78)

Clinical Feature	Number of Patients	Percentage (%)
Periorbital swelling	72	92.31
Pain	64	82.05
Fever	58	74.36
Restricted ocular movements	46	58.97
Proptosis	34	43.59
Visual disturbance	22	28.21

Table 3: Comparison of CT and MRI Findings in Orbital Cellulitis (n = 78)

Imaging Finding	CT Detected n (%)	MRI Detected n (%)	p-value
Preseptal involvement	62 (79.49)	64 (82.05)	0.684
Postseptal involvement	48 (61.54)	56 (71.79)	0.046*
Extraocular muscle enlargement	42 (53.85)	52 (66.67)	0.031*
Optic nerve involvement	14 (17.95)	26 (33.33)	0.012*
Sinus involvement	60 (76.92)	62 (79.49)	0.715

*Statistically significant ($p < 0.05$)

Table 4: Detection of Complications by CT and MRI (n = 78)

Complication	CT n (%)	MRI n (%)	p-value
Subperiosteal abscess	18 (23.08)	24 (30.77)	0.041*
Orbital abscess	10 (12.82)	16 (20.51)	0.039*
Cavernous sinus thrombosis	4 (5.13)	10 (12.82)	0.048*
Intracranial extension	2 (2.56)	8 (10.26)	0.028*
Bony erosion	12 (15.38)	10 (12.82)	0.637

*Statistically significant ($p < 0.05$)

Table 5: Diagnostic Performance of CT and MRI Using Composite Reference Standard

Modality	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Diagnostic Accuracy (%)
CT	76.92	82.35	85.71	71.79	79.49
MRI	91.03	88.24	92.86	85.29	89.74
p-value	-	-	-	-	**0.018***

*Statistically significant ($p < 0.05$)

DISCUSSION

In the present study (n = 78), males constituted 56.41% and the most frequent age group was 21–40 years (28.21%), indicating a slight male predominance and clustering in young-to-middle adulthood. A similar demographic trend was reported by Chaudhry et al (2007) in a large tertiary-care series of 218 orbital cellulitis cases, where 136 were males (62.39%) and the mean age was 25.7 years, supporting that orbital cellulitis commonly affects younger age groups and may show male predominance in hospital-based cohorts.[8]

Clinically, our patients most commonly presented with periorbital swelling (92.31%), pain (82.05%), and fever (74.36%), while proptosis (43.59%) and visual disturbance (28.21%) were less frequent but clinically important due to their association with postseptal disease. In contrast, Ailal et al (2004) (33 pediatric cases) reported fever and local edema in 100% and exophthalmia in 6/33 (18.18%), reflecting that pediatric cohorts may present with universal systemic signs yet comparatively lower proptosis rates than our mixed-age tertiary population; importantly, their retroseptal group showed serious neurologic complications including empyema (2/33; 6.06%), meningitis (1/33; 3.03%), and cavernous sinus thrombophlebitis (1/33; 3.03%), which aligns with our finding that intracranial/vascular complications, although less common, are clinically decisive and require sensitive imaging.[9]

Sinonasal disease was highly prevalent in our study (sinus involvement: CT 76.92% vs MRI 79.49%), reinforcing sinusitis as a key source for orbital infection. In Dewan et al (2011), among 49 patients with orbital cellulitis, 24 (48.98%) had radiographic evidence of subperiosteal abscess (SPA) and all SPA patients had concurrent sinusitis, demonstrating a strong sinus–SPA linkage; compared with that SPA-enriched cohort, our complication burden was lower (SPA: MRI 30.77%), but the high sinus association in both studies supports routine assessment of paranasal sinuses alongside orbital imaging.[10]

A key observation in our comparative imaging results was MRI's higher detection of deeper orbital involvement: postseptal involvement (MRI 71.79% vs CT 61.54%; p = 0.046), extraocular muscle enlargement (66.67% vs 53.85%; p = 0.031), and optic nerve involvement (33.33% vs 17.95%; p = 0.012). Classic CT-based work by Handler et al (1991) (65 acute orbital inflammatory cases) found subperiosteal abscess in 48/65 (73.85%) and emphasized a crucial limitation—CT could not reliably differentiate 33 pus-containing abscesses from 6 inflammatory masses (phlegmons)—highlighting that CT may identify collections but can struggle with tissue characterization, which helps explain why MRI (with superior soft-tissue contrast) performed better in delineating postseptal spread and neuro-ocular involvement in our cohort.[11]

Our study also demonstrated MRI superiority for detecting complications: orbital abscess (MRI 20.51% vs CT 12.82%; p = 0.039), cavernous sinus thrombosis (12.82% vs 5.13%; p = 0.048), and intracranial extension (10.26% vs 2.56%; p = 0.028), while CT remained comparable for bony erosion (p = 0.637). The value of advanced MRI sequences is supported by Sepahdari et al (2009), who reviewed 9 MRI-imaged orbital cellulitis cases including 6/9 (66.67%) with pyogenic abscess and concluded that diffusion-weighted imaging (DWI) improved diagnostic confidence in nearly all orbital abscess cases, explaining why MRI (especially with DWI and post-contrast fat-suppressed sequences) is better suited than CT for confirming abscess, defining its margins, and detecting vascular/intracranial spread—patterns consistent with our higher MRI detection rates for soft-tissue and intracranial complications.[12]

From a management perspective, our findings suggest CT may be sufficient for initial assessment of bony anatomy and sinus disease, but MRI adds critical value when deeper spread or complications are suspected. Noël et al (1990) prospectively evaluated 23 children with true orbital cellulitis and performed CT in 10, where CT showed medial rectus–adjacent edema or muscle thickening/displacement in 8/10 (80.00%); despite CT suspicion, only 3 required sinus/orbital drainage and frank subperiosteal pus was found in only 1/3 (33.33%), illustrating that imaging “collection-like” findings do not always equate to drainable pus. This supports our observation that MRI's better tissue characterization (and abscess confirmation) can reduce diagnostic uncertainty and better triage patients toward medical therapy versus timely surgery.[13]

In our cohort, abscess-related complications were substantial (SPA 30.77%, orbital abscess 20.51% on MRI), yet remained below some series that are enriched for surgically relevant disease. Erickson et al (2015) reported abscesses in 56.7% of 30 patients and showed a strong age effect: adults had abscesses in 28.6% vs children in 81.3% (p = 0.008). Given our mixed population with the largest group in 21–40 years, the comparatively lower abscess burden in our results is consistent with their observation that adults are less likely than children to present with abscess, while still underscoring that a meaningful fraction of adults develop complications requiring high-sensitivity imaging.[14]

Overall diagnostic performance in our study favored MRI (sensitivity 91.03%, specificity 88.24%, accuracy 89.74%) over CT (sensitivity 76.92%, specificity 82.35%, accuracy 79.49%), with a statistically significant difference in accuracy (p = 0.018). This is directionally consistent with Younis et al (2002), who compared clinical assessment, CT, and

MRI in 82 patients with complicated sinusitis and found CT accuracy 91% for orbital complications and MRI accuracy 97% for intracranial complications (vs CT 87%), supporting the principle reflected in our data: CT performs well for orbital/sinonasal assessment, but MRI becomes increasingly decisive when intracranial or vascular complications are suspected.[15]

CONCLUSION

This comparative study demonstrates that both CT and MRI are valuable imaging modalities in the evaluation of orbital cellulitis; however, MRI shows significantly higher sensitivity and diagnostic accuracy in detecting postseptal involvement, optic nerve changes, and orbital as well as intracranial complications. CT remains an effective first-line modality for assessing sinonasal disease and bony involvement, particularly in emergency settings. MRI provides important incremental information in complex or equivocal cases and when complications are suspected. An integrated imaging approach tailored to clinical severity can optimize management and improve patient outcomes.

REFERENCES

1. Lee S, Yen MT. Management of preseptal and orbital cellulitis. *Saudi J Ophthalmol.* 2011;25(1):21–29. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC3729811/
2. Bedwell J, Bauman NM. Management of pediatric orbital cellulitis and abscess. *Curr OpinOtolaryngol Head Neck Surg.* 2011;19(6):467–473. Available from: https://pubmed.ncbi.nlm.nih.gov/22001661/
3. Bedwell JR, Choi SS. Medical versus surgical management of pediatric orbital subperiosteal abscesses. *Laryngoscope.* 2013;123(10):2337–2338. doi:10.1002/lary.24014. Available from: https://pubmed.ncbi.nlm.nih.gov/23606325/
4. Dankbaar JW, van Bemmel AJM, Pameijer FA. Imaging findings of the orbital and intracranial complications of acute bacterial rhinosinusitis. *Insights Imaging.* 2015;6(5):509–518. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC4569601/
5. Pakdaman MN, Sepahdari AR, Elkhamary SM. Orbital inflammatory disease: Pictorial review and differential diagnosis. *World J Radiol.* 2014;6(4):106–115. doi:10.4329/wjr.v6.i4.106. Available from: https://pubmed.ncbi.nlm.nih.gov/24778772/
6. Rudloe TF, Harper MB, Prabhu SP, Rahbar R, Vanderveen D, Kimia AA. Acute periorbital infections: who needs emergent imaging? *Pediatrics.* 2010;125(4):e719–e726. doi:10.1542/peds.2009-1709. Available from: https://pubmed.ncbi.nlm.nih.gov/20194288/
7. Liao JC, Harris GJ. Subperiosteal abscess of the orbit: evolving pathogens and the therapeutic protocol. *Ophthalmology.* 2015;122(3):639–647. doi:10.1016/j.ophtha.2014.09.009. Available from: https://pubmed.ncbi.nlm.nih.gov/25439602/
8. Chaudhry IA, Shamsi FA, Elzaridi E, et al. Outcome of treated orbital cellulitis in a tertiary eye care center in the middle East. Ophthalmology. 2007;114(2):345-354. doi:10.1016/j.ophtha.2006.07.059. Available from: https://pubmed.ncbi.nlm.nih.gov/17270683/
9. Ailal F, Bousfiha A, Jouhadi Z, et al. [Orbital cellulitis in children: a retrospective study of 33]. Med Trop (Mars). 2004;64(4):359-362. Available from: https://pubmed.ncbi.nlm.nih.gov/15615387/
10. Dewan MA, Meyer DR, Wladis EJ. Orbital cellulitis with subperiosteal abscess: demographics and management outcomes. Ophthalmic Plast Reconstr Surg. 2011;27(5):330-332. doi:10.1097/IOP.0b013e31821b6d79. Available from: https://pubmed.ncbi.nlm.nih.gov/21629136/
11. Handler LC, Davey IC, Silvester CL. The acute orbit: differentiation of orbital cellulitis from subperiosteal abscess by computerized tomography. Neuroradiology. 1991;33(3):257-260. Available from: https://pubmed.ncbi.nlm.nih.gov/2027437/
12. Sepahdari AR, Aakalu VK, Kapur R, et al. MRI of orbital cellulitis and orbital abscess: the role of diffusion-weighted imaging. AJR Am J Roentgenol. 2009;193(3):W244-W250. doi:10.2214/AJR.08.1838. Available from: https://pubmed.ncbi.nlm.nih.gov/19696266/
13. Noël LP, Clarke WN, MacDonald N. Clinical management of orbital cellulitis in children. Can J Ophthalmol. 1990;25(1):11-16. Available from: https://pubmed.ncbi.nlm.nih.gov/2328431/
14. Erickson BP, Lee WW, Yen MT, et al. Orbital Cellulitis and Subperiosteal Abscess: A 5-year Outcomes Analysis. Ophthalmic Plast Reconstr Surg. 2015. (Abstract data as indexed in PubMed). Available from: https://pubmed.ncbi.nlm.nih.gov/25867948/
15. Younis RT, Anand VK, Davidson B. The role of computed tomography and magnetic resonance imaging in patients with sinusitis with complications. Laryngoscope. 2002;112(2):224-229. Available from: https://pubmed.ncbi.nlm.nih.gov/11889374/