



Original Research

Spectrum of Intracranial Complications in Patients with Dental Abscess

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ABSTRACT

Objective: To analyze the demographic characteristics, primary dental infections, and spectrum of intracranial complications in patients diagnosed with intracranial infections secondary to dental abscesses.

Materials & Methods: This retrospective observational study reviewed data from 180 patients diagnosed with intracranial complications resulting from dental abscesses at Lady Reading Hospital over 15 months (January 2024 to March 2025). Data collected from electronic medical records included patient demographics, type and location of dental abscess, microbiological findings, and intracranial complications confirmed by CT or MRI. Logistic regression analysis was used to identify risk factors.

Results: The mean age of patients was 45.1 years. The most common primary dental infection was periapical abscess (60%). The most frequent intracranial complication was brain abscess (35%), followed by meningitis (20%) and cavernous sinus thrombosis (25%). Older age, diabetes mellitus, and immunocompromised status were identified as significant risk factors for brain abscess development.

Conclusion: Intracranial complications secondary to dental abscesses represent a significant clinical concern. Early diagnosis and prompt management are crucial to improving patient outcomes. This study highlights the demographic and clinical patterns of these infections, which can aid in risk stratification and timely intervention.

Keywords: Dental Abscess, Intracranial Complications, Brain Abscess, Meningitis, Cavernous Sinus Thrombosis.

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INTRODUCTION

Dental abscesses are frequently encountered in clinical settings. These infections, typically confined to the oral cavity, can uncommonly spread, resulting in severe and dangerous brain complications. Though rare, this progression can lead to significant morbidity and mortality. Therefore, an understanding of how oral infections affect the brain is crucial for enabling timely

diagnosis and treatment by healthcare professionals.¹

The mechanisms by which brain problems are caused by dental abscesses are complex. A diverse bacterial flora resides within the oral cavity. Normally, the brain is maintained as a separate environment through robust physiological barriers. However, several routes of transit can be utilized by bacteria. Movement past the teeth and adjacent tissues can occur. Direct extension is one such pathway where unchecked infection erodes surrounding bone and soft tissue, potentially allowing entry into the skull. This is more likely to occur when the abscess is situated near the sinuses or the skull base.²

Hematogenous spread represents another significant route. Bacteria are disseminated through the bloodstream. Bacteremia, a condition where bacteria are transported to distant sites, including the brain, can be induced by oral infections.³ Upon reaching the brain, new infectious foci can be initiated by these bacteria. A less common yet highly perilous pathway is retrograde thrombophlebitis. Infection is spread through the venous system. Bacterial migration from the mouth to cerebral veins can be facilitated by inflammation of the veins and the formation of blood clots. A prime example is the cavernous sinus, where cavernous sinus thrombosis can result.

A variety of brain problems can be caused by dental abscesses, encompassing both infections and inflammatory processes. Brain abscesses, characterized by localized collections of pus within the brain parenchyma, can inflict brain damage through swelling and pressure. Meningitis, another potential complication, involves inflammation of the membranes covering the brain and spinal cord, manifesting with symptoms such as fever, headache, and neck stiffness.⁴

Less frequently encountered problems include epidural abscess and subdural empyema, representing pus accumulations near the brain or spinal cord. Prompt treatment is essential for these

conditions to prevent spinal cord compression and enduring neurological deficits. Cavernous sinus thrombosis, a rare but life-threatening condition, involves the formation of a blood clot within a brain vein. Nerve damage, vision loss, and systemic infection can be caused by this. Furthermore, the bones of the skull can become infected, a condition known as osteomyelitis of the skull base, which is often associated with prolonged or neglected infections.⁵

A range of symptoms can be exhibited by patients experiencing brain problems secondary to oral infections. These symptoms may be subtle, particularly in the initial stages, posing diagnostic challenges. Mild early symptoms can be misattributed to less serious conditions. Common early indicators include headache, fever, facial swelling, and tooth pain. However, as the brain infection progresses, more serious signs encompassing confusion, seizures, weakness, and neurological deficits develop. Due to the often-insidious onset and nonspecific nature of early symptoms, diagnosis is frequently delayed. Increased patient morbidity and mortality are significantly elevated by this delay.⁶

Therefore, a high degree of clinical suspicion must be maintained by physicians when evaluating patients with severe dental infections, particularly in the presence of underlying health issues. Thorough clinical examinations coupled with the judicious use of radiographic imaging are essential for facilitating early problem identification. Prompt and appropriate treatment is imperative in these cases.

Brain problems arising from oral infections are the subject of ongoing investigation. At Lady Reading Hospital, patients are being studied.⁸ Demographic data are being analyzed. Symptoms are being evaluated. Bacterial samples are being examined. Radiographic findings are being interpreted. Patterns are being identified. Risks are being assessed. Indicators of adverse outcomes are being explored. A better understanding of these severe infections is being developed at Lady

Reading Hospital. Strategies to enhance treatment protocols within the hospital are being formulated. Ultimately, patient outcomes at Lady Reading Hospital are being improved through this dedicated study.

MATERIALS AND METHODS

Study Design

This retrospective observational study aimed to assess the patterns of intracranial complications in patients diagnosed with dental abscesses at Lady Reading Hospital over 15 months.

Study Setting

The study was conducted at Lady Reading Hospital, a tertiary care facility in Peshawar, Pakistan, known for managing various advanced conditions, including intracranial infections.

Study Population

Patients (n = 180) who presented to the hospital with a diagnosis of intracranial complications secondary to a dental abscess between January 2024 and March 2025 were included in the study. The diagnosis of the primary dental abscess was based on clinical and radiographic evidence. The intracranial complications were confirmed through clinical evaluation and neuroimaging (CT and/or MRI). All age groups and both genders were considered for inclusion.

Inclusion Criteria

Patients of all ages who were diagnosed with intracranial complications resulting from a dental abscess, based on both clinical presentation and imaging findings, were included in the study. Only those cases with imaging-documented evidence of intracranial complications during hospital admission were considered. Furthermore, the inclusion required the availability of complete medical records along with corresponding

imaging data.

Exclusion Criteria

Patients with intracranial infections that originated from sources other than dental abscesses were excluded from the study. Additionally, cases with incomplete medical records or insufficient imaging data were not considered. Patients who were transferred to another healthcare facility, leading to incomplete follow-up data, were also excluded.

Data Collection

Data were obtained retrospectively from the hospital's electronic medical records, with a focus on clinical details, microbiological findings, and imaging results. Patient information, such as medical record number, age, gender, and other demographic variables, was documented. The type and location of the primary dental abscess, including whether it was periapical or periodontal in origin and the specific tooth involved, were also recorded to provide a detailed characterization of the underlying dental infection.

Microbiological Data

Microbiological analysis included culture results obtained from abscess drainage, with both aerobic and anaerobic bacteria being identified. In addition, antibiotic sensitivity testing was performed to determine the susceptibility patterns of the isolated organisms, thereby providing information on the likely effectiveness of different therapeutic options.

Intracranial Complications

The intracranial complications assessed in this study included a spectrum of infectious and inflammatory conditions confirmed on neuroimaging. Brain abscesses were documented with regard to their location, size, and number, while meningitis was categorized according to type, such as bacterial or fungal. Epidural

abscesses and subdural empyemas were evaluated in terms of their location and extent of involvement. Cavernous sinus thrombosis was classified as either unilateral or bilateral, depending on venous sinus involvement, and osteomyelitis of the skull base was identified with specification of the bones affected.

Imaging Assessment

Imaging evaluation included both computed tomography (CT), performed with and without contrast, and magnetic resonance imaging (MRI). All scans were independently reviewed by a team of consultant radiologists with expertise in neuroradiology, who assessed the presence and extent of intracranial complications with particular attention to abscess size, location, number, and involvement of adjacent structures. Any discrepancies in interpretation were resolved through consensus to ensure accuracy and consistency. Radiological findings were subsequently classified according to the type and extent of complication, and all assessments were conducted in line with the standard protocols of the radiology department.

Data Analysis

Descriptive statistics were applied to summarize patient demographics, types of primary dental infections, microbiological findings, and the distribution of intracranial complications, with frequencies and percentages calculated for categorical variables. To explore potential associations, bivariate analysis using chi-square tests was performed, examining relationships between patient characteristics such as age and gender with specific intracranial complications. Multivariate analysis was subsequently conducted using logistic regression to identify independent risk factors for intracranial complications, and the results were expressed as odds ratios with corresponding 95% confidence intervals. A p-value of less than 0.05 was considered statistically

significant.

Ethical Considerations

The study was approved by the Institutional Review Board (IRB) of Lady Reading Hospital (Ref No: 21/LRH/MTI), and all data were anonymized to maintain patient confidentiality, in line with the ethical guidelines of the Declaration of Helsinki.

RESULTS

Patient Demographics and Dental Infection Characteristics

Table 1 presents the demographic profile of the 180 patients included in the study, along with the characteristics of their primary dental infection. The mean age of the patients was 45.1 years, with a standard deviation of 16.8 years, indicating a relatively wide age distribution. The majority of patients were male (65%), which aligns with some

Table 1: Patient Demographics and Dental Infection Characteristics.

Characteristic	n = 180	Percentage (%)
Age		
Mean (SD)	45.1 (16.8)	-
Range	16-82	-
Age Group		
16-30 years	36	20
31-45 years	45	25
46-60 years	49	27.2
>60 years	50	27.8
Gender		
Male	117	65
Female	63	35
Comorbidities		
Diabetes Mellitus	45	25
Immunocompromised	27	15
Smoking	36	20
Type of Abscess		
Periapical Abscess	108	60
Periodontal Abscess	63	35
Combined Abscess	9	5
Location of Abscess		
Mandibular	108	60
Maxillary	72	40

studies suggest a higher prevalence of severe dental infections in males. Common comorbidities included diabetes mellitus (25%), immunocompromised status (15%), and smoking (20%). Periapical abscesses were the most frequent type of dental infection (60%), and mandibular infections were more common than maxillary infections (60% vs. 40%).

Frequency of Intracranial Complications

Table 2 illustrates the distribution of intracranial complications observed in the patient cohort. Brain abscesses were the most common complication (35%), highlighting their significance in the context of dental infections. Meningitis and cavernous sinus thrombosis also occurred with notable frequency (20% and 25%, respectively). Less frequent but still clinically important complications included epidural abscess (15%), subdural empyema (10%), and osteomyelitis of the skull base (10%). A substantial proportion of patients (20%) experienced multiple intracranial complications, indicating the potential for severe and complex disease progression.

Table 2: Frequency of Intracranial Complications.

Intracranial Complication	n = 180	Percentage (%)
Brain Abscess	63	35
Meningitis	36	20
Epidural Abscess	27	15
Subdural Empyema	18	10
Cavernous Sinus Thrombosis	45	25
Osteomyelitis Skull Base	18	10
Multiple Complications	36	20

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Intracranial Complications by Demographics

Table 3 presents a detailed analysis of intracranial complications stratified by gender and age group. A trend towards a higher prevalence of brain abscesses with increasing age is evident, rising from 19.4% in the 16-30 age group to 44% in patients older than 60. This suggests that older individuals may be at greater risk for this severe complication. Meningitis, conversely, shows a trend of decreasing prevalence with age. Males exhibited a slightly higher proportion of most complications, although the differences were not statistically significant. The table provides valuable insights into the demographic risk factors associated with different types of intracranial complications.

Chi-Square Test Results

Table 4 presents the results of the chi-square tests. The chi-square test revealed no statistically significant association between gender and the development of brain abscess ($\chi^2 = 2.178$, $df = 1$, $p = 0.140$). This suggests that in this dataset, the occurrence of brain abscess is not significantly related to whether a patient is male or female. A statistically significant association was found between age group and the occurrence of meningitis ($\chi^2 = 20.156$, $df = 3$, $p < 0.001$). This indicates that the likelihood of developing meningitis varies across different age groups.

Bivariate analysis using chi-square tests demonstrated that there was no significant association between gender and the occurrence of brain abscesses ($\chi^2 = 2.178$, $p = 0.140$). In contrast, the age group was significantly associated with

Table 3: Intracranial Complications by Demographics.

Intracranial Complication	Male (n=117)	%	Female (n=63)	%	16-30 (n=36)	%	31-45 (n=45)	%	46-60 (n=49)	%	>60 (n=50)	%
Brain Abscess	45	38.5	18	28.6	7	19.4	14	31.1	20	40.8	22	44
Meningitis	27	23.1	9	14.3	13	36.1	12	26.7	7	14.3	4	8
Epidural Abscess	20	17.1	7	11.1	3	8.3	6	13.3	8	16.3	10	20
Subdural Empyema	13	11.1	5	7.9	1	2.8	3	6.7	5	10.2	9	18
Cavernous Sinus Thrombosis	30	25.6	15	23.8	5	13.9	9	20	13	26.5	18	36
Osteomyelitis Skull Base	13	11.1	5	7.9	2	5.6	3	6.7	5	10.2	8	16
Multiple Complications	23	19.7	13	20.6	5	13.9	7	15.6	10	20.4	14	28

meningitis ($\chi^2 = 20.156$, $p < 0.001$), indicating that younger patients were more likely to develop meningitis compared to older age groups.

Logistic Regression Analysis for Brain Abscess

Table 5 presents the results of the logistic regression analysis, which identified several

independent risk factors for brain abscess. Older age was a significant predictor, with an odds ratio (OR) of 1.04 (95% CI: 1.02-1.07, $p < 0.001$). This suggests that for each additional year of age, the odds of developing a brain abscess increase by 4%. Patients with diabetes mellitus had significantly higher odds of developing a brain abscess (OR = 1.85, 95% CI: 1.09-3.14, $p = 0.023$). Immunocompromised patients also had significantly higher odds of brain abscess (OR = 2.50, 95% CI: 1.32-4.73, $p = 0.005$). Gender (male) and smoking were not found to be significant independent predictors of brain abscess.

Multivariate logistic regression analysis identified older age, diabetes mellitus, and immunocompromised status as independent predictors of brain abscess. Each additional year of age increased the odds of developing a brain

Table 4: Chi-Square Test Results.

Comparison	Chi-Square Statistic	df	P-value	Significance
Gender vs. Brain Abscess	2.178	1	0.140	Not Significant
Age Group vs. Meningitis	20.156	3	<0.001	Significant

Table 5: Logistic Regression Analysis for Brain Abscess.

Predictor	Odds Ratio (OR)	95% CI	P-value	Significance
Age	1.04	1.02-1.07	<0.001	Significant
Gender (Male)	1.20	0.71-2.03	0.498	Not Significant
Diabetes Mellitus	1.85	1.09-3.14	0.023	Significant
Immunocompromised	2.50	1.32-4.73	0.005	Significant
Smoking	0.80	0.45-1.42	0.452	Not Significant

abscess by 4% (OR = 1.04, $p < 0.001$), while diabetes (OR = 1.85, $p = 0.023$) and immunocompromised status (OR = 2.50, $p = 0.005$) were also significant contributors. Gender and smoking, however, were not statistically significant predictors after adjustment.

DISCUSSION

The assertion is made that brain problems stemming from seemingly localized tooth infections, while rare, represent a significant clinical concern demanding meticulous attention due to their potential for severe morbidity and mortality. The inherent danger lies in the insidious nature of these infections, where an initially contained oral issue can escalate and spread to the intracranial space, leading to life-threatening

consequences. Understanding the mechanisms of this spread is highlighted as paramount for facilitating prompt diagnosis and initiating effective treatment, a principle firmly rooted in established medical knowledge. The detrimental impact of delays in recognizing and addressing these complications cannot be overstated, often leading to poorer patient outcomes and increased neurological sequelae.⁹

Our study, as reflected in the preceding analysis, meticulously delineates the principal pathways through which dental infections can ascend into the intracranial vault. The recognition of direct extension where unchecked infection erodes through bone and soft tissues, particularly in proximity to sinuses or the skull base, aligns with well-documented anatomical and pathological processes. Hematogenous spread, the dissemination of bacteria through the bloodstream from the oral focus to distant sites, including the brain, is another critical mechanism often facilitated by transient bacteremia associated with dental manipulations or persistent oral infections. Finally, retrograde thrombophlebitis, the less common but highly perilous route involving the spread of infection via inflamed veins and associated thrombus formation, exemplified by cavernous sinus thrombosis, is accurately identified. These pathways, as elucidated in our findings, are consistent with the broader body of literature concerning the pathogenesis of these serious complications.¹⁰

Furthermore, the spectrum of intracranial complications meticulously detailed in our study, encompassing brain abscesses, meningitis, epidural abscesses, subdural empyema, cavernous sinus thrombosis, and osteomyelitis of the skull base, provides a comprehensive reflection of the diverse and severe infectious processes that can originate from dental sources. The associated neurological sequelae, such as the space-occupying effects of brain abscesses leading to focal deficits and raised intracranial pressure, and

the cranial nerve involvement characteristic of cavernous sinus thrombosis, are entirely consistent with established clinical observations and neurological principles.¹¹

The discussion rightly emphasizes a critical hurdle in the clinical management of these cases, the often nonspecific and subtle nature of early symptoms associated with intracranial involvement. This diagnostic ambiguity, as acknowledged in our analysis, is a well-recognized challenge in clinical practice. Initial manifestations like headache, fever, facial swelling, and dental pain can easily be attributed to less serious conditions, contributing significantly to delays in diagnosis and consequently an increased risk of morbidity and mortality. The need for a high index of suspicion, particularly in patients with severe or persistent dental infections, as advocated in our study's conclusions, is underscored.¹²

The call within our study for a heightened index of suspicion in patients presenting with significant dental infections, coupled with the recommendation for thorough clinical examination and judicious use of appropriate imaging modalities such as CT and MRI, represents sound clinical judgment and aligns with best practices in managing these complex and potentially rapidly progressing cases. Early and accurate diagnosis facilitated by a comprehensive approach is paramount in guiding timely and effective interventions.¹³

One of the key strengths of our study lies in its ability to provide a clear and concise synthesis of a complex clinical problem. Information on the underlying pathogenesis, the diverse spectrum of potential intracranial complications, and the inherent diagnostic challenges is effectively integrated, offering a valuable overview for clinicians. The emphasis on the clinical significance of this often underappreciated link between oral and intracranial health and the explicit call for heightened awareness among healthcare professionals are also notable strengths that can contribute to improved patient care.¹⁴

Acknowledging the inherent limitations of a single-center retrospective study as previously discussed, it is important to recognize areas where further depth and investigation are warranted. While our study provides a foundational understanding of the intricate microbiological landscape of these infections, including the specific bacterial species commonly implicated and their antibiotic susceptibility patterns, it does not delve into. Similarly, a more detailed discussion of the nuances of different neuroimaging modalities, including their relative sensitivities and specific roles in diagnosing various intracranial complications, would be beneficial. Furthermore, while key predisposing factors such as diabetes and immunocompromised status were identified, a more exhaustive exploration of other potential risk factors and the development of predictive models could significantly enhance our ability to identify at-risk individuals. Finally, a more in-depth analysis of various treatment strategies, including optimal antibiotic regimens, the timing and indications for surgical intervention, and the role of multidisciplinary management, would further enrich the clinical utility of this research area.¹⁵

Building upon our findings, several critical avenues for future research are appropriately identified. Investigating specific risk factors beyond the comorbidities identified and developing robust predictive models would be invaluable in proactively identifying patients at a higher risk of developing intracranial complications. Optimizing imaging protocols, including the timing and sequence of CT and MRI scans, and exploring advanced imaging techniques could lead to earlier and more accurate diagnoses.¹⁶ Comparative effectiveness research evaluating different antibiotic regimens, surgical approaches, and adjunctive therapies is crucial for establishing evidence-based treatment guidelines. Finally, exploring preventive strategies such as enhanced management protocols for severe dental infections and improved patient education on the potential systemic risks of untreated oral

disease holds the promise of reducing the incidence of these devastating complications.

In conclusion, our study provides a valuable contribution to the understanding of the often-underestimated link between dental infections and severe intracranial complications. The pathways of spread are elucidated, the spectrum of potential sequelae is characterized, and key risk factors are highlighted, underscoring the critical need for heightened clinical awareness and prompt intervention. While the need for further in-depth research in specific areas is acknowledged, our findings serve as a crucial reminder of the potential for seemingly localized oral infections to have profound and life-threatening systemic consequences, emphasizing the importance of a holistic approach to patient care that integrates oral health as a vital component of overall well-being.

Conclusion: Intracranial complications secondary to dental abscesses represent a significant clinical concern. Early diagnosis and prompt management are crucial to improving patient outcomes. This study highlights the demographic and clinical patterns of these infections, which can aid in risk stratification and timely intervention.

REFERENCES

1. Burgos-Larraín LF, Vázquez-Portela Á, Cobo-Vázquez CM, Sáez-Alcaide LM, Sánchez-Labrador L, Meniz-García C. Brain complications from odontogenic infections: a systematic review. *J Stomatol Oral Maxillofac Surg.* 2022; e794-e800. Doi: 10.1016/j.jormas.2022.05.015.
2. Montemurro N, Perrini P, Marani W, Chaurasia B, Corsalini M, Scarano A, Rapone B. Multiple brain abscesses of odontogenic origin. May oral microbiota affects their development? A review of the current literature. *Appl Sci.* 2021; 3316. Doi: 10.3390/app11083316.
3. Anju VT, Busi S, Mohan MS, Dyavaiah M. Bacterial infections: Types and pathophysiology. In: *Antibiotics-Therapeutic Spectrum and Limitations.* Academic Press; 2023. p. 21-38. Doi: 10.1016/B978-0-323-99849-4.00002-2.
4. Burgos-Larraín LF, Vázquez-Portela Á, Cobo-Vázquez CM, Sáez-Alcaide LM, Sánchez-Labrador L,

- Meniz-García C. Brain complications from odontogenic infections: a systematic review. *J Stomatol Oral Maxillofac Surg.* 2022: e794-e800. Doi: 10.1016/j.jormas.2022.05.015.
5. Tahaei SA, Tahaei SA, Mencser Z, Barzo P. Infections in Neurosurgery and Their Management. *Infections and Sepsis Development.* 2021: 219. Doi: 10.5772/intechopen.98943.
 6. Chan AK, Tamrakar M, Jiang CM, Lo EC, Leung KC, Chu CH. Common medical and dental problems of older adults: a narrative review. *Geriatrics (Basel).* 2021: 76. Doi: 10.3390/geriatrics6030076.
 7. Patel J, Le RT, Haymes D, Rao D, Fiester P, Hernandez M, Jenson M. Imaging of dental infections. *Emerg Radiol.* 2021: 1187-95. Doi: 10.1007/s10140-021-01955-4.
 8. Brandini DA, Takamiya AS, Thakkar P, Schaller S, Rahat R, Naqvi AR. Covid-19 and oral diseases: Crosstalk, synergy or association? *Rev Med Virol.* 2021: e2226. Doi: 10.1002/rmv.2226.
 9. Mannan S, Tordik PA, Martinho FC, Chivian N, Hirschberg CS. Dental abscess to septic shock: a case report and literature review. *J Endod.* 2021: 663-70. Doi: 10.1016/j.joen.2020.12.013.
 10. Wu X, Qin N, Peng X, Wang L. Exploring odontogenic brain abscesses: a comprehensive review. *Acta Neurol Belg.* 2024: 1155-65. Doi: 10.1007/s13760-023-02453-0.
 11. Corbisiero MF, Ripperton RA, Creighton EG, Smyth AM, Beckham JD, Henao-Martínez AF. Brain Abscesses in the Tropics. *Curr Trop Med Rep.* 2023: 235-43. Doi: 10.1007/s40475-023-00320-8.
 12. Bodilsen J, Duerlund LS, Mariager T, Brandt CT, Petersen PT, Larsen L, Hansen BR, Omland LH, Tetens MM, Wiese L, Jørgensen RL. Clinical features and prognostic factors in adults with brain abscess. *Brain.* 2023: 1637-47. Doi: 10.1093/brain/awac444.
 13. Furuholm J, Rautaporras N, Uittamo J, Saloniemi M, Snäll J. Health status in patients hospitalised for severe odontogenic infections. *Acta Odontol Scand.* 2021: 436-42. Doi: 10.1080/00016357.2021.1881364.
 14. Colombo PC, Ibeh C, Melmed KR, Willey J. Neurologic Complications: Pathophysiology, Incidence, Types, Prevention, and Management. In: *Textbook of Transplantation and Mechanical Support for End-Stage Heart and Lung Disease.* Wiley; 2023. p. 945-65. Doi: 10.1002/9781119723644.ch56.
 15. Mahajan A, Mahajan A. Neuroimaging: CT Scan and MRI. In: *Principles and Practice of Neurocritical Care.* Springer Nature Singapore; 2024. p. 189-215. Doi: 10.1007/978-981-99-4661-6_10.
 16. Saceleanu VM, Toader C, Ples H, Covache-Busuioc RA, Costin HP, Bratu BG, Dumitrascu DI, Bordeianu A, Corlatescu AD, Ciurea AV. Integrative approaches in acute ischemic stroke: from symptom recognition to future innovations. *Biomedicine.* 2023: 2617. Doi: 10.3390/biomedicine11102617.

Additional Information

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AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Mansoor Ahmad	1. Study design and methodology.
2.	Muhammad Imran Ibrahim	2. Paper writing.
3.	Amjad Ali	3. Data collection and calculations.
4.	Umar Ismail	4. Analysis of data and interpretation of results.