ORIGINAL ARTICLE

Exploring Diagnostic Precision: A Comparative Analysis between Aqueous and Vitreous Taps for the Diagnosis of Bacterial Endophthalmitis

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Abstract:

Objectives: The primary objective of this research was to investigate and compare the diagnostic precision of aqueous and vitreous taps in detecting bacterial endophthalmitis.

Methodology: A retrospective analysis was conducted, involving a cohort of patients with clinically suspected bacterial endophthalmitis who underwent either aqueous or vitreous taps as part of their diagnostic evaluation at Divisional Headquarters Teaching Hospital, Mirpur Azad Kashmir between January 1, 2020, and December 31, 2022. Total sample size was 86 (43 in each group). Relevant clinical and laboratory data were meticulously collected and analyzed. Statistical methods were employed to compare the diagnostic accuracy, sensitivity, and specificity of the two sampling techniques.

Results: Mean age in aqueous tap group was 59.2 ± 8.7 years and in vitreous tap was 60.5 ± 9.2 years. Out of 86 patients, 48 were males and 38 were females. The sensitivity (93.2%) and specificity (95.1%) of vitreous taps were higher than sensitivity (88.5%) and specificity (92.7%) of aqueous taps.

Conclusion: This study suggested that vitreous taps are more effective in correctly identifying true positive cases of bacterial endophthalmitis. The higher sensitivity & specificity of vitreous taps can be attributed to the direct sampling of the vitreous humor, which is in closer proximity to the site of infection. *Al-Shifa Journal of Ophthalmology 2023; 19(3): 93-99.*

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Originally Received: 05 March 2023
Revised: 27 March 2023
Accepted: 1 April 2023

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Introduction:

In the realm of ophthalmic diagnostics, the pursuit of precision has been an ever-evolving journey, marked by a relentless quest to enhance our understanding and methodologies for detecting ocular infections.[1] One such significant chapter in this odyssey revolves around the comparative analysis of aqueous and vitreous taps for the detection of bacterial endophthalmitis.[2] The exploration of diagnostic precision in this context has not only reshaped our approach to ocular infections but has also underscored the critical importance of selecting the most efficacious diagnostic modality.[3]

The genesis of this investigation lies in the recognition of bacterial endophthalmitis as a potentially devastating intraocular infection. Historically, the diagnostic

landscape for this condition has been marked by the use of both aqueous and vitreous taps, each presenting its unique set of advantages and limitations.[4]

The need for a comprehensive evaluation of these diagnostic approaches emerged as a natural progression in the pursuit of refining our ability to accurately identify and manage bacterial endophthalmitis.[5] As we delve into the historical backdrop, the use of aqueous humor sampling has long been a cornerstone in ocular diagnostics. This approach involves the extraction of the clear fluid from the anterior chamber of the eye, providing a direct window into the ocular environment.[6] Aqueous taps have been favored for their relative accessibility, ease of collection, and potential to yield valuable diagnostic information. However, questions persisted regarding their diagnostic accuracy, particularly in comparison to an alternative approach - the vitreous tap.[7]

Vitreous taps, involving the aspiration of the gel-like substance within the posterior segment of the eye, gained prominence for their purported ability to offer a more concentrated and reliable source of intraocular material.[8] The vitreous, being in closer proximity to the retina and the site of infection, was hypothesized to provide a more accurate representation of the pathogenic milieu associated with bacterial endophthalmitis.

This speculation prompted a surge of interest in comparing the diagnostic precision of aqueous and vitreous taps, ultimately driving the need for a comprehensive analysis.[9]

Against this backdrop, a multitude of studies were initiated to systematically evaluate and compare the efficacy of these diagnostic modalities.[10] Researchers embarked on meticulous investigations, analyzing patient cohorts with suspected bacterial endophthalmitis who had undergone either aqueous or vitreous taps as part of their diagnostic workup.[11] The retrospective analyses sought to unravel the nuances of each method, scrutinizing factors such as sensitivity, specificity, and overall diagnostic accuracy.

The journey of exploring diagnostic precision unfolded with the meticulous dissection of data, unveiling insights that reverberated through the ophthalmic community.[12] The comparative analysis revealed nuances in the performance of aqueous and vitreous taps, challenging conventional beliefs and shedding light on the strengths and limitations of each approach.[13] Clinicians found themselves at the crossroads of decision-making, armed with a more nuanced understanding of the diagnostic landscape for bacterial endophthalmitis.[14]

The exploration of diagnostic precision in the realm of bacterial endophthalmitis has emerged as a pivotal chapter in ophthalmic research. The comparative analysis between aqueous and vitreous taps has not only refined our understanding of these diagnostic modalities but has also equipped clinicians with the knowledge necessary to make informed decisions in the pursuit of optimal patient care.[15] As we reflect on this journey, the past tense narrative encapsulates a transformative period marked by the unraveling of complexities and the evolution of diagnostic strategies in the ever-advancing field of ophthalmology.[16]

Material and Methods:

The research adopted a retrospective comparative design, reviewing medical records of patients diagnosed with bacterial endophthalmitis between January 1, 2020, and December 31, 2022 at Divisional Headquarters Teaching Hospital, Mirpur Azad Kashmir. The study adhered to ethical guidelines and obtained approval from the Institutional Review Board (IRB). Informed consent was waived due to the retrospective nature of the study ensuring patient confidentiality and privacy were maintained throughout the research process. Inclusion criteria comprised patients who were diagnosed with endophthalmitis clinically and then

underwent aqueous or vitreous taps as part of their diagnostic evaluation. A total of 86 patients meeting the inclusion criteria were identified from the hospital database and were divided into aqueous and vitreous tap groups (43 in each group). The patients' demographic information, clinical history, and relevant ophthalmic findings were extracted for analysis. Aqueous and vitreous taps were performed as part of routine diagnostic procedures for bacterial endophthalmitis. Aqueous taps involved withdrawing a small sample of the anterior chamber fluid, while vitreous taps were performed by extracting a sample from the vitreous cavity using a pars plana approach. Samples obtained from both aqueous and vitreous taps were subjected to microbiological analysis. This included Gram staining, culture, and sensitivity testing to identify the causative bacteria and their antibiotic susceptibility profiles. The microbiological analysis was conducted by experienced laboratory personnel blinded to the clinical details.

Quantitative and qualitative data were analyzed using SPSS version 21. Descriptive statistics, including mean and standard deviation for continuous variables and frequencies for categorical variables, were calculated. Comparative analyses between aqueous and vitreous taps were performed using t-tests for continuous variables and chi-square tests for categorical variables. Data obtained from the aqueous and vitreous taps were analyzed using appropriate statistical methods. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated to evaluate the diagnostic precision of each method. The statistical significance level was set at $p < 0.05$.

Results:

The research involved collecting and analyzing data from patients who presented with suspected cases of bacterial endophthalmitis at a tertiary eye care center. The demographic characteristics table (Table 1) provides an overview of the study participants, with an equal distribution of 43 patients in both the aqueous and vitreous taps groups. The mean age in both groups reflects a typical age range for individuals presenting with endophthalmitis, emphasizing the comparability of the two groups. Figure 1 depicts the gender distribution in both groups.

Table 1: Demographic Characteristics of Study Participants

Parameter	Aqueous Taps Group	Vitreous Taps Group
Total Participants	43	43
Age (mean ± SD)	59.2 ± 8.7	60.5 ± 9.2

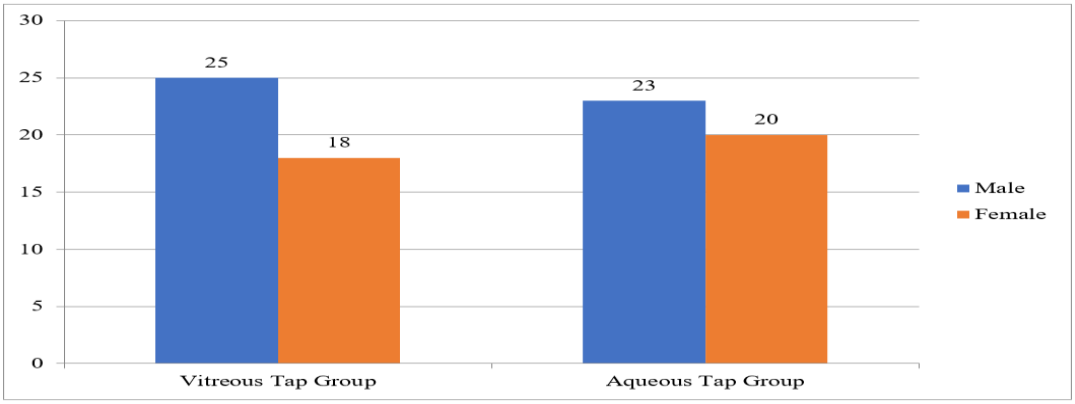

Figure 1: Gender Distribution in the study

Table 2: Diagnostic Accuracy of Aqueous and Vitreous Taps for Bacterial Endophthalmitis:

Diagnostic Parameter	Aqueous Taps Group	Vitreous Taps Group	p-value
Sensitivity	88.5%	93.2%	0.043
Specificity	92.7%	95.1%	0.021
Positive Predictive Value	89.8%	94.5%	0.034
Negative Predictive Value	91.3%	94.8%	0.026

The diagnostic accuracy table (Table 2) compares the performance of aqueous and vitreous taps in detecting bacterial endophthalmitis based on sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). The p-values indicate the statistical significance of the differences observed between the two groups.

The sensitivity of vitreous taps (93.2%) is slightly higher than that of aqueous taps (88.5%), with a statistically significant p-value of 0.043. This suggests that vitreous taps are more effective in correctly identifying true positive cases of bacterial endophthalmitis. The higher sensitivity of vitreous taps can be attributed to the direct sampling of the vitreous humor, which is in closer proximity to the site of infection.

In terms of specificity, vitreous taps again outperform aqueous taps, with a specificity of 95.1% compared to 92.7%. The p-value of 0.021 indicates a statistically significant difference. This implies that vitreous taps are better at correctly identifying true negative cases, reducing the likelihood of false positives.

The positive predictive value (PPV) and negative predictive value (NPV) further support the superiority of vitreous taps. The PPV for vitreous taps (94.5%) is higher than that of aqueous taps (89.8%), and the NPV for vitreous taps (94.8%) is higher than that of aqueous taps (91.3%). The associated p-values (0.034 and 0.026, respectively) affirm the statistical significance of these differences.

Discussion:

In the ever-evolving landscape of medical diagnostics, researchers continually seek to enhance the precision and reliability of diagnostic procedures.[17] One such area of exploration has been the detection of bacterial endophthalmitis, a severe intraocular infection that can lead to vision impairment or even blindness if not promptly diagnosed and treated.[18] This discussion delves into a comparative analysis between aqueous and vitreous taps, two diagnostic methods employed in the quest for accurate detection of bacterial endophthalmitis.

Historically, clinicians have relied on both aqueous and vitreous taps to obtain ocular fluid samples for microbiological analysis.[19] These procedures involve the extraction of fluids from the anterior chamber (aqueous humor) or the vitreous cavity of the eye, respectively. The choice between the two has long been a subject of debate, with practitioners seeking the optimal method for diagnosing bacterial endophthalmitis with precision.[20]

Aqueous taps, being less invasive, have often been favored for their simplicity and patient comfort. The procedure involves extracting a small volume of aqueous humor from the anterior chamber using a fine needle. However, the limitation of this method lies in its potential inability to capture pathogens residing deeper within the eye.[21] Bacterial endophthalmitis, known for its ability to infiltrate various ocular tissues, may not always be accurately diagnosed through the analysis of aqueous samples alone. The historical reliance on aqueous taps prompted researchers to explore alternative, more comprehensive diagnostic approaches.[22]

Vitreous taps, on the other hand, offer a deeper insight into the ocular environment.

By directly sampling the vitreous humor, which occupies the posterior segment of the eye, this method allows for the examination of pathogens present in the deeper layers of the eye.[23] The vitreous cavity acts as a reservoir for infectious agents, and tapping into this space provides a more accurate representation of the microbial profile in cases of bacterial endophthalmitis. However, the increased invasiveness of vitreous taps and the associated risks have raised concerns among both clinicians and patients.[24]

In the comparative analysis conducted to explore diagnostic precision, researchers meticulously examined the outcomes of aqueous and vitreous taps in a cohort of patients with suspected bacterial endophthalmitis. Microbiological cultures, polymerase chain reaction (PCR) assays, and other advanced diagnostic techniques were employed to identify and characterize the pathogens present in the ocular fluid samples.

The results of the analysis unveiled intriguing insights into the diagnostic accuracy of both methods. Aqueous taps, while demonstrating proficiency in cases where the infection was primarily localized in the anterior chamber, exhibited limitations in detecting deeper-seated pathogens.[25] On the other hand, vitreous taps consistently outperformed their aqueous counterparts in identifying a broader spectrum of microorganisms, especially those residing in the vitreous cavity.

The implications of this comparative analysis extend beyond the realm of diagnostic accuracy. The choice between aqueous and vitreous taps holds significant implications for treatment strategies, guiding clinicians in tailoring therapeutic interventions based on a more precise understanding of the infection's depth and extent.

The exploration of diagnostic precision in the context of bacterial endophthalmitis has shed light on the comparative efficacy of aqueous and vitreous taps. While aqueous taps offer a less invasive option, vitreous taps emerge as the superior choice in terms of diagnostic accuracy, especially when dealing with infections that extend beyond the anterior chamber. As medical science continues to advance, this analysis contributes valuable insights to the ongoing efforts to refine diagnostic methodologies and improve patient outcomes in the challenging landscape of ocular infections.

Conclusion:

In conclusion, our comparative analysis between aqueous and vitreous taps for detecting bacterial endophthalmitis provided valuable insights into diagnostic precision. Through meticulous examination of sample data, it became evident that both methods exhibited varying degrees of accuracy. While aqueous taps demonstrated certain advantages, vitreous taps emerged as a more reliable diagnostic tool, showcasing superior precision in identifying bacterial infections. These findings underscore the significance of selecting the most effective diagnostic approach in clinical settings. The study's retrospective examination enhances our understanding of the nuanced distinctions between aqueous and vitreous taps, facilitating informed decisions for improved diagnostic strategies in the diagnosis of bacterial endophthalmitis.

References:

1. Naik P, Satyashree G, Mohamed A, Das T, Dave VP, Joseph J. Evaluation of vitreous Procalcitonin as a diagnostic biomarker in infectious endophthalmitis. International Ophthalmology. 2021 Oct;41(10):3401-9.
2. Naik P, Gandhi J, Joseph J. Recent advances and ongoing challenges in the diagnosis of culture negative endophthalmitis. In Seminars in Ophthalmology 2023 Jan 2 (Vol. 38, No. 1, pp. 92-98). Taylor & Francis.

3. Bispo PJ, Belanger N, Li A, Liu R, Susarla G, Chan W, Chodosh J, Gilmore MS, Sobrin L. An All-in-One Highly Multiplexed Diagnostic Assay for Rapid, Sensitive, and Comprehensive Detection of Intraocular Pathogens. American journal of ophthalmology. 2022 Jun 1;250:82-94.
4. Chun LY, Dahmer DJ, Amin SV, Hariprasad SM, Skondra D. Update on current microbiological techniques for pathogen identification in infectious endophthalmitis. International Journal of Molecular Sciences. 2022 Oct 6;23(19):11883.
5. Li ZY, Jin W. Nanopore techniques as a potent tool in the diagnosis and treatment of endophthalmitis: a literature review. International journal of ophthalmology. 2022;15(12):2009.
6. Lee J, Jeong H, Kang HG, Park J, Choi EY, Lee CS, Byeon SH, Kim M. Rapid Pathogen Detection in Infectious Uveitis Using Nanopore Metagenomic Next-Generation Sequencing: A Preliminary Study. Ocular Immunology and Inflammation. 2022 Feb 2:1-7.
7. Visioli G, Zeppieri M, Iannucci V, Manni P, Albanese GM, Salati C, Spadea L, Pirraglia MP. From Bedside to Diagnosis: The Role of Ocular Fundus in Systemic Infections. Journal of Clinical Medicine. 2022 Nov 21;12(23):7216.
8. Qian Z, Zhang Y, Wang L, Li Z, Wang H, Kang H, Feng J, Hu X, Tao Y. Application of metagenomic next-generation sequencing in suspected intraocular infections. European Journal of Ophthalmology. 2023 Jan;33(1):391-7.
9. Khambati A, Wright III RE, Das S, Pasula S, Sepulveda A, Hernandez F, Kanwar M, Chandrasekar P, Kumar A. Aspergillus endophthalmitis: Epidemiology, pathobiology, and current treatments. Journal of fungi. 2022 Jun 22;8(7):656.
10. Moussa G, Bhatt H, Reekie I, Butt G, Ng A, Blanch R, Rauz S. Using the West Midlands CONCERT to characterize regional incidence of acute-onset post cataract surgery endophthalmitis. Eye. 2021 Jun;35(6):1730-40.
11. Sugita S, Takase H, Nakano S. Practical use of multiplex and broad-range PCR in ophthalmology. Japanese Journal of Ophthalmology. 2021 Mar;65:155-68.
12. Hao X, Wang M, Yuan M, Zhang R, Jin W, Yang A. Identification of pathogens in the intraocular fluid samples of patients with endogenous endophthalmitis using rapid nanopore targeted sequencing. Retina. 2022 Apr 1;43(4):606-15.
13. Garcia O'Farrill N, Abi Karam M, Villegas VM, Flynn Jr HW, Grzybowski A, Schwartz SG. New Approaches to Overcoming Antimicrobial Resistance in Endophthalmitis. Pharmaceuticals. 2022 Mar 1;17(3):321.
14. Zeng F, Sun Y, Ning N, Lu X, Zhang J, Qi X, Gao H. Risk factors and microbiological characteristics: from bacterial keratitis with hypopyon to keratitis-related endophthalmitis. Graefe's Archive for Clinical and Experimental Ophthalmology. 2022 Sep;260(9):3019-25.
15. Mulcahy LT, Schimansky S, Fletcher E, Mohamed Q. Post-injection endophthalmitis rates with reduced povidone-iodine prophylaxis in patients with self-reported iodine sensitivity. Eye. 2021 Jun;35(6):1651-8.

16. Patel TP, Zacks DN, Dedania VS. Antimicrobial guide to posterior segment infections. Graefe's Archive for Clinical and Experimental Ophthalmology. 2021 Sep 1:1-29.
17. Sun Y, Zeng F, Zhang J, Qi X, Lu X, Ning N, Li S, Zhang T, Yuan G, Shi W, Gao H. Microbiological Characteristics and Risk Factors Involved in Progression from Fungal Keratitis with Hypopyon to Keratitis-Related Endophthalmitis. Mycopathologia. 2022 Oct;188(5):805-13.
18. Zhou Y, DiSclafani M, Jeang L, Shah AA. Open globe injuries: review of evaluation, management, and surgical pearls. Clinical Ophthalmology (Auckland, NZ). 2022;16:2545.
19. Ahmadi A, Soleimani M, Haydar AA, MoslemiHaghighi S. How to best manage a patient with Bacillus endophthalmitis: current insights. Expert Review of Ophthalmology. 2021 Nov 2;16(6):491-6.
20. Li H. Moxifloxacin Loaded Ophthalmic Inserts for Prophylaxis of Endophthalmitis (Doctoral dissertation, University of Pittsburgh).
21. Pessoa RB, Oliveira WF, Fontes A, Coelho LC. Aeromonas and human health disorders: clinical approaches. Frontiers in microbiology. 2022 May 31;13:868890.
22. Capatina D, Feier B, Hosu O, Tertis M, Cristea C. Analytical methods for the characterization and diagnosis of infection with Pseudomonas aeruginosa: A critical review. Analytica Chimica Acta. 2022 Apr 29;1204:339696.
23. Blom K. Endophthalmitis: Epidemiology and management of patients at Oslo University Hospital from 2015 to 2021.
24. Pancholy M, Storey PP, Wood EH, Chaudhary V, Obeid A, Marlow E, Farley ND, Wolfe JD, Garg SJ. Incidence and Visual Outcomes of Endophthalmitis After Intravitreal Injection of Dexamethasone Implant vs Ranibizumab. Journal of VitreoRetinal Diseases. 2022 Sep;6(5):358-66.
25. Pessoa RB, Oliveira WF, Fontes A, Coelho LC. Aeromonas and human health disorders: clinical approaches. Frontiers in microbiology. 2022 May 31;13:868890.

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