

Diagnostic Application of B-Scan Ultrasonography

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ABSTRACT

Objective: To investigate the role of B-scan ultrasonography in diagnosing ocular disorders.

Study Design: A retrospective study

Place and Duration of Study: This study was conducted at the Saidu Group of Teaching Hospital from September 2022 to September 2023.

Methods: A retrospective study was conducted on a total of 100 patients with media opacity due to cataracts, diabetes, corneal dystrophy, trauma, leukocoria, hypertension or Eale's disease. B-scan ultrasonography, systemic exams, optical acuity tests, and other in-depth diagnostics were conducted.

Results: Patients ranged in age from 6 months to 80 years, with the highest prevalence of ocular disorders observed in the 11 to 20-year age group (45%). Various ocular pathologies were identified, including corneal pathologies (5%), mature cataracts (9%), vitreous hemorrhage (7%), retinal detachment (15%), tractional retinal detachment (12%), retinoblastoma (3%), and others. Notably, 44 patients (44%) had multiple concurrent pathologies. Traumatic injuries, particularly in males aged 11 to 30, were a leading cause of ocular pathology. B-scan ultrasonography was critical in trauma assessment, cataract surgery planning, vitreous hemorrhage management, detecting intraocular foreign bodies, and diagnosing post-traumatic endophthalmitis.

Conclusion: B-scan ultrasonography is indispensable in diagnosing a wide spectrum of ocular disorders, especially in cases of media opacity. This study underscores its significance in trauma evaluation, cataract surgery, vitreous hemorrhage management, foreign body detection, and post-traumatic endophthalmitis diagnosis.

Key Words: B-scan ultrasonography, ocular disorders, ophthalmology.

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INTRODUCTION

Sonar, echography, and acoustic imaging all fall under the broad category of "ultrasound." However, the technology's origins can be traced back to World War I, when it was developed largely as a way of detecting submerged objects, in particular submarines. This cutting-edge innovation is founded on established pulse-echo imaging. Ultrasound produces echoes at the boundaries of tissues with different acoustic impedances. The echo is more apparent when there is a larger difference in acoustic impedance between the tissues.

It is important to note that the frequency of ultrasonic waves utilized in medicine is often higher than 20 KHz.¹ Ultrasound frequencies between 8 and 10 MHz are used for most routine eye exams in ophthalmology.

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The shorter wavelengths that result from using a high frequency make it possible to see intricate details in the eye's microscopic structures. On the other hand, ultrasound of the abdomen often operates at much lower frequencies, anywhere from 1 to 5 MHz. The longer wavelengths this selection produces are more effective at reaching deep into biological tissues.² ultrasonic imaging encompasses a series of steps, commencing with the emission of ultrasonic waves, followed by their reflection off interior structures, subsequent receiving of the reflected echoes, electrical amplification, and visualization in a graphical format. Two often employed methods for displaying this data are the "A-scan" and the "B-scan".³ The A-scan modality presents a unidimensional representation, where each peak's vertical dimension is proportional to the amplitude and intensity of the accompanying echo. In contrast, the B-scan modality shows echoes in the form of dots rather than spikes, where the magnitude of these dots corresponds to the intensity of the reflections. This modality provides a two-dimensional, cross-sectional depiction of the globe and orbit of the eye. Significantly, this technique distinguishes between less intense reflections from vitreous cells and more intense reflections from retinal tissues, sclera, and calcifications.⁴ The B-scan is widely utilized in ophthalmology due to its multifunctionality and high level of accuracy.⁵ This technique is utilized to assess the anterior or posterior segments of the eyes when

there is a hindrance caused by opacity in the eye's media. Moreover, it facilitates determining the dimensions of ocular neoplasms, differentiation between posterior vitreous detachment (PVD) and retinal detachment (RD) as opposed to vitreous haemorrhage, evaluation of orbital abnormalities, and identification and localization of intraocular foreign objects. In brief, ultrasonic technology, which originated from the imperative demands of war, has seen significant advancements and emerged as an indispensable instrument within the realm of medicine, specifically emphasizing ophthalmology. The indispensable nature of optical coherence tomography (OCT) lies in its capacity to offer thorough and non-invasive imaging of ocular structures, hence facilitating the diagnosis and management of a diverse array of eye-related disorders and illnesses.

METHODS

This study was conducted as a retrospective and observational investigation of 100 patients who presented with opaque media resulting from different underlying reasons. These causes included trauma, diabetes mellitus, hypertension, congenital or acquired mature cataracts, corneal dystrophy, leukocoria, and Eale's disease. The study was conducted at Saidu Group of Teaching Hospital from September 2022 to September 2023. A standardized proforma was utilized to collect patient data, encompassing a comprehensive range of parameters. The comprehensive clinical history encompassed several variables, such as diminished visual acuity, a history of trauma, occupational factors, coagulation problems, previous medical or surgical procedures, and comorbidities like diabetes, hypertension, or prior vitrectomy. A comprehensive overall assessment was conducted, which included a comprehensive physical examination and evaluations of several bodily systems. The measurement of visual acuity accomplished the quantification of vision impairment, while the intraocular pressure (IOP) assessment was conducted to screen for glaucoma. Minor media opacities were evaluated for anterior segment defects using slit lamp examination (SLE) and slit lamp biomicroscopy. In addition, while evaluating the back of the eye, indirect ophthalmoscopy was used when there was only modest opacity. This study relied heavily on B-scan ultrasonography, namely that performed with U.S.-based business Alcon's Occuscan technology. Measurements of blood pressure, glucose, lipids, coagulation time, complete blood counts, rheumatoid arthritis (RA) factor, antinuclear antibody (ANA) factor, and radiographic studies like X-rays of the chest (posteroanterior view) and the orbit were taken as needed. In the B-scan procedure, a coupling gel is used to place a probe against the closed eyelid for optimal acoustic coupling. As a result, intraocular structures

may be seen in real time. Statistical tests were performed on the information gleaned from the diagnostic and proforma forms. Patient characteristics, medical background, and test outcomes were summarised using descriptive statistics. Ethical considerations were given considerable weight in this work, as indicated by the approval granted by the Saidu Group of Teaching Hospital's Institutional Review Board (diagnosis). Ethical considerations were also taken into account by obtaining the agreement of all participants or their guardians. Appropriate software was used to do the statistical analysis, and inferential statistics were applied when necessary. Taking into account both the expected prevalence and the study's manageability, a sample size of 100 cases was determined. The study has some limitations, including a potential for selection bias and reliance on a single imaging modality, as well as its retrospective nature. However, these obstacles were overcome with the help of diligent data collection and analytical techniques. This research provided a comprehensive and methodical strategy for identifying the causes of opaque media in the eyes. B-scan ultrasonography's value as a diagnostic tool in such scenarios was highlighted. The study set out to further our understanding of how B-scan ultrasonography may be used in the diagnosis of ocular disorders.

RESULTS

The research included a heterogeneous sample of patients ranging in age from 6 months to 80 years. A significant incidence of ocular diseases was seen in the age group of 11 to 20 years, as indicated by the most significant number of patients, totaling 45 persons (45%). On the other hand, the age group with the lowest representation consisted of five patients (5%) aged between 71 and 80 years.

Table No.1: Age Distribution of Patients Requiring B-scan Examination

Age Group (Years)	Number of Patients
0-10	10
11-20	45
21-30	10
31-40	10
41-50	10
51-60	10
61-70	10
71-80	5

It is worth noting that a noteworthy correlation exists between an experience of trauma and those belonging to younger age cohorts, particularly those aged 11 to 30 years. About the distribution of gender, it was observed that 70 patients (70%) were identified as male, whilst 30 patients (30%) were identified as female. This finding indicates a greater occurrence of ocular

disorders necessitating B-scan evaluation among men within this particular group.

Table No.2: Ocular Pathologies Requiring B-scan Examination

Ocular Pathology	Number of Patients
Corneal Pathology	5
Mature Cataract	9
Vitreous Hemorrhage	7
Retinal Detachment	15
Tractional Retinal Detachment	12
Retinoblastoma	3
Optic Nerve Anomaly	2
Choroidal Thickening	1
Persistent Hyperplastic Primary Vitreous (PHPV)	1
Asteroid Hyalosis	1
Multiple Pathologies	44

A range of ocular diseases were seen within the patient population. It is worth mentioning that five individuals exhibited various corneal diseases, such as traumatic scarring, dystrophy, post-viral or bacterial corneal opacity, abscess, or descemetocoele. The presence of mature cataracts was seen in many cases, explicitly impacting nine individuals. Seven individuals were diagnosed with vitreous hemorrhage, whereas retinal detachment was observed in 15 cases. A total of 12 individuals were found to exhibit tractional retinal detachment. A notable subset of patients consisted of three individuals diagnosed with retinoblastoma, two with optic nerve defects, and one with choroidal thickness. Furthermore, one patient was diagnosed with Persistent Hyperplastic Primary Vitreous (PHPV), while another displayed Asteroid Hyalosis symptoms. Significantly, a considerable proportion of the sample, consisting of 44 individuals, demonstrated the presence of several diseases that impacted both the anterior and posterior parts of the eye. The findings of this study highlight the wide range of ocular disorders that need B-scan ultrasonography. Specifically, it focuses on the prevalence of these illnesses in relation to age, gender, and the occurrence of numerous concurrent pathologies.

DISCUSSION

The results of this study emphasize the wide range of ocular illnesses that need B-scan ultrasonography, showing different patterns of prevalence and importance across different groups of patients. These results yield some significant observations and implications. The occurrence of ocular disease, namely traumatic injuries, has been identified as a prominent factor, regardless of whether blunt or piercing mechanisms cause them. This phenomenon predominantly affects individuals who identify as male and fall within the age range of 11 to 30 years. This

conclusion is consistent with the prevailing consensus that individuals in this age cohort are more susceptible to experiencing trauma as a result of heightened engagement in outdoor activities and involvement in sports. Other published research has also documented similar patterns, highlighting the susceptibility of this population to ocular injury.⁶ Ocular injuries of a traumatic nature frequently harm various tissues within the eye, such as the cornea, lens, iris, vitreous, or retina. To evaluate the severity of the injury and make informed treatment decisions, it is sometimes necessary to do a B-scan examination.

The B-scan evaluation is paramount in facilitating cataract surgery within the setting of advanced cataracts. The presence of mature cataracts is marked by the development of opacity in the lens, resulting in impaired visualization of intraocular structures for the surgeon. The use of B-scan imaging offers significant insights into the posterior segment, hence facilitating the process of surgical strategizing and guaranteeing a technique that is both secure and efficient.⁷ The study identifies vitreous hemorrhage as a notable observation linked to a range of underlying illnesses such as diabetes, hypertension, Eale's disease, traumatic accidents, retinal tear or fractures, and idiopathic reasons^{8,9,10}. When vitreous haemorrhage fails to clear spontaneously, a prompt B-scan examination becomes necessary. The examination has significant importance for vitreoretinal surgeons as it allows them to evaluate the extent of haemorrhage, determine the root reasons, and strategize appropriate therapies, including vitrectomy¹¹. The significance of the B-scan in directing the therapy of vitreous haemorrhage is of utmost importance¹².

Prompt evaluation of B-scan imaging is essential for detecting intraocular foreign bodies, particularly those made of highly reactive substances like iron, zinc, copper or aluminum. The aforementioned substances possess toxicity towards the photoreceptor cells located in the retina, perhaps resulting in permanent harm if not expeditiously identified and remedied^{13,14}. On the other hand, it is worth noting that non-reactive foreign objects such as stone, sand, glass, porcelain, or plastic may not necessitate an urgent B-scan inspection. The distinction has significant importance in enhancing patient care and allocating resources within healthcare environments¹⁵. The research also provided insights into the frequency of post-traumatic endophthalmitis, a serious and sight-endangering consequence often linked to penetrating eye injuries and foreign objects within the eye¹⁶. This discovery highlights the significance of early identification and treatment, particularly in rural or non-hospital environments with restricted availability of specialized ophthalmic care¹⁷.

CONCLUSION

In conclusion, this study has significantly advanced our knowledge of the importance of B-scan ultrasonography in the diagnosis and management of a wide range of ocular illnesses, particularly those when media opacity is present. Significant insights into the prevalence and characteristics of various pathological disorders have been revealed by the study results, clarifying the age and gender distribution of affected individuals. People between the ages of 11 and 30 who are physically active are disproportionately affected by ocular problems brought on by traumatic traumas. The urgency of assessing and treating this population is therefore highlighted. Mature cataracts, vitreous haemorrhage, and conditions such as retinal detachment were frequently observed indications for B-scan examination, underscoring its pivotal role in facilitating cataract surgery, providing guidance for vitreoretinal interventions, and distinguishing between different vitreous and retinal pathologies. Additionally, the research emphasized the relevance of timely B-scan examination in instances involving intraocular foreign bodies, especially those made of reactive substances. It also highlighted the significance of B-scan examination in diagnosing post-traumatic endophthalmitis. In ophthalmology, B-scan ultrasonography has emerged as an essential and invaluable technique. It provides a non-invasive and thorough method for evaluating ocular structures, especially when direct visualization is hindered by media opacity. The aforementioned findings have significant importance in the optimization of patient care, the preservation of eyesight, and the guidance of treatment decisions. With the continuous advancement of technology and the deepening of our understanding of ocular diseases, the utilization of B-scan ultrasonography is anticipated to assume a more prominent position within the realm of ophthalmology. This will augment our capacity to identify and manage intricate eye problems.

Limitations and Recommendations for Future Studies: This retrospective research uses incomplete and inaccurate historical records, which may induce biases and data constraints. The research only included individuals with opaque media, which may have excluded milder or earlier-stage instances. Conducted at one institution, the results may not reflect wider demographics and healthcare settings. B-scan ultrasonography is useful, although it lacks the detail of OCT or MRI, requiring comparison research. Finally, although feasibility determines sample size, it may restrict statistical power and subgroup exploration. Future ocular pathology and B-scan ultrasonography research should emphasize prospective study designs to eliminate retrospective biases and improve data accuracy. Multiple demographic and geographic patient groups should be considered to better understand eye

diseases' prevalence and features. To aid clinical decision-making, B-scan ultrasonography should be compared to OCT and MRI. B-scan imaging longitudinally following illness development may reveal disease dynamics. Telemedicine B-scan ultrasonography trials might improve eye care access. Pathology detection might be automated using advanced data analytics and AI. Future research should examine the effects of B-scan ultrasonography on patient outcomes and its safety and cost-effectiveness compared to other diagnostic methods.

Author's Contribution:

Concept & Design of Study: Sher Akbar Khan
 Drafting: Jan Zada
 Data Analysis: Salma Liaqat
 Revisiting Critically: Sher Akbar Khan, Jan Zada
 Final Approval of version: Sher Akbar Khan

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