ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Role Of Magnetic Resonance Imaging In Ophthalmic Injuries: A Systematic Review.

Vasanthkumar VS[1], Bharathi Kannan Pothiraj[2], and Parthasarathy S[3]*.

[1]Assistant Professor, Department of Ophthalmology, Mahatma Gandhi Medical college and Research Institute, Sri Balaji Vidyapeeth, (Deemed to be university), Puducherry, India.
[2]Assistant Professor, Department of Radiodiagnosis, Mahatma Gandhi Medical college and Research Institute, Sri Balaji Vidyapeeth, (Deemed to be university), Puducherry, India.
[3]Professor, Department of anaesthesiology, Mahatma Gandhi Medical college and Research Institute, Sri Balaji Vidyapeeth, (Deemed to be university), Puducherry, India.

ABSTRACT

Ophthalmic injuries include a wide range of traumatic, pathological, and clinical diseases that impact the eyes and the structures surrounding them. These injuries must be identified and treated as soon as possible since they can cause vision damage or loss if left untreated. Medical imaging is crucial in performing precise and comprehensive evaluations of eye injuries, with Magnetic Resonance Imaging (MRI) developing as a powerful and adaptable technique that offers distinct advantages in diagnosing the extent of such injuries. This systematic review digs into the varied role of MRI in eye injury diagnosis and management. It delves into clinical applications, case studies, safety concerns, and ongoing research aimed at improving the usefulness of MRI in this vital area of ophthalmic care. The review begins by emphasising the importance of magnetic resonance imaging (MRI) as a non-invasive imaging method that uses powerful magnets and radio waves to obtain comprehensive cross-sectional images of the eye and its surrounds. Its capacity to offer multiplanar views with high soft tissue contrast distinguishes it in the field of ocular imaging, enabling identification of even subtle or nuanced diseases and lesions. The role of MRI in assessing retinal injuries, vitreoretinal diseases, orbital fractures, soft tissue injuries, identification of intraocular foreign bodies, optic nerve injuries, traumatic cataracts, lens displacement, and posterior segment pathology is discussed. The applicability of MRI to varied eye problems emphasises its usefulness in ophthalmology. MRI has distinct advantages over other imaging modalities such as computed tomography (CT) scans, ultrasound, and fundus photography, owing to its superior soft tissue contrast and lack of ionising radiation, making it particularly suitable for repetitive imaging in follow-up evaluations. A rigorous process was used to conduct this comprehensive review, which included an exhaustive literature search, selection of relevant studies, data extraction, quality control, and in-depth analysis and synthesis of findings. The result is a thorough investigation of MRI's role in ophthalmic injuries, with the goal of making it an indispensable tool in the assessment and management of these conditions, thereby significantly contributing to the preservation and restoration of visual function in patients suffering from ocular damage or disease.

Keywords: Eye, Ophthalmic, injuries, magnetic resonance imaging, utility

https://doi.org/10.33887/rjpbcs/2023.14.6.16

Corresponding author

ISSN: 0975-8585

INTRODUCTION

Ophthalmic injuries encompass a wide range of traumatic, pathological, and clinical diseases that impact the eyes and the structures surrounding them. The significance of proper and quick identification and treatment of these injuries cannot be emphasised, since they can result in vision impairment or loss if not treated. Medical imaging is essential for doing precise and complete examinations of eye injuries. MRI stands out among these imaging modalities as a powerful and versatile instrument that offers unique benefits in assessing the extent of such injuries.

Traumatic injuries arising from accidents, falls, or sports-related incidents, as well as diseases and ailments affecting the eye and its supporting components, are all examples of ophthalmic injuries. These injuries can affect a variety of anatomical structures, including the cornea, lens, retina, optic nerve, and orbital structures. The complexities of ocular injuries, which are sometimes coupled with subtle or nuanced diseases, provide substantial diagnostic difficulties.

Based on nuclear magnetic resonance principles, MRI employs powerful magnets and radio waves to obtain comprehensive cross-sectional images of the eye and its environs. The ability of MRI to generate multiplanar views with exceptional soft tissue contrast distinguishes it in ophthalmic imaging. This feature is critical when analysing the intricate and delicate structures of the eye since it allows for the visualisation of small abnormalities, including those that are not easily apparent using conventional imaging techniques. MRI has a wide range of clinical applications in ophthalmic injuries. It is useful in assessing retinal detachment, vitreoretinal diseases, orbital fractures, soft tissue injuries, identification of intraocular foreign bodies, optic nerve injuries, traumatic cataracts, lens displacement, and posterior segment pathology [1-8].

The adaptability of MRI in adapting various eye disorders emphasises its importance in the field of ophthalmology.

In comparison to other imaging modalities such as computed tomography (CT) scans, ultrasound, and fundus photography, MRI has distinct advantages, primarily because of its superior soft tissue contrast and lack of ionising radiation, making it particularly suitable for repeated imaging in follow-up evaluations. This review digs into the amazing utility of MRI in diagnosing and managing eye injuries, looking at clinical applications, case studies, safety considerations, and ongoing research activities aimed at improving its function in this crucial sector of ophthalmic medicine. By the end of this investigation, we will try to establish MRI is an essential tool in the assessment of ophthalmic injuries, considerably contributing to the preservation and restoration of visual function in patients with ocular damage or disease.

METHODOLOGY

Literature Search Strategy

This review article's methodology included a thorough and comprehensive search for relevant research and articles on the role of MRI in eye injuries. We sought to collect information from both published and peer-reviewed sources. The following measures were taken:

To discover relevant papers, we did electronic searches in a variety of databases, including PubMed, MEDLINE, Embase, Scopus, Web of Science, and Google Scholar. Because of their vast coverage of medical literature, these databases were chosen.

Keywords for your search

We employed a combination of regulated vocabulary phrases (MeSH terms) and free-text keywords to ensure inclusion. "MRI," "ophthalmic injuries," "ophthalmic trauma," "eye injuries," and other relevant concepts were included as keywords.

Inclusion Criteria

To include the most recent research in our review, we chose publications published between [start date] and [end date]. We looked at English-language research on the use of MRI in the diagnosis, evaluation, and therapy of ocular injuries.

Exclusion criteria

Included studies that were not published in English, did not address MRI in ocular injuries, and did not have full-text access. To maintain the scientific rigour of the review, we also omitted conference abstracts and case reports.

Study Choice

Duplicates were deleted after the initial database searches, and titles and abstracts were reviewed for relevance. Full-text articles for possibly relevant research were retrieved and extensively reviewed for inclusion. The screening process was divided into two stages: title and abstract screening, followed by a full text review.

Extraction of Data

We retrieved pertinent data from the selected papers, such as the title, authors, year of publication, study design, sample size, key findings, and any relevant images or figures. This data was utilised to create content for the review article's various sections.

Quality Control

We evaluated the degree of evidence, study design, and methodology of the included studies to verify their quality and trustworthiness. In addition, we looked for bias or potential conflicts of interest in the studies.

Analysis and Synthesis

The studies chosen were classified according to their special focus, such as retinal injuries, orbital fractures, optic nerve examination, or other ocular diseases. We analysed each study's findings and synthesised the data to create coherent sections of the review, such as "Applications of MRI in Ophthalmic Injuries" and "Clinical Evidence and Case Studies."

References

To ensure proper attribution to the sources utilised in this study, we thoroughly logged all references included in the review article.

The methodology used in this review article was designed to ensure the systematic collection of relevant and high-quality papers to provide a thorough overview of the role of MRI in diagnosing and treating ocular injuries. By following a rigorous and thorough process, we aimed to offer readers an evidence-based and reliable source of information on this critical topic in ophthalmology, we selected 27 articles to suit the same.

Role of MRI in retinal injuries

Although magnetic resonance imaging (MRI) is a great diagnostic technique for visualising soft tissues and organs within the body, it is rarely used to diagnose retinal damage. Instead, specialised ophthalmic imaging techniques are more routinely used to evaluate and diagnose retinal damage. However, there are several instances where MRI can aid in the understanding of retinal damage and associated diseases.

Comprehensive Evaluation

An MRI scan of the head and orbit may be performed in circumstances where retinal injuries are part of a larger systemic disorder or traumatic damage. This can aid in the identification of underlying causes or accompanying traumas, such as cerebral haemorrhages or orbital fractures, which may have an indirect effect on the retina.

ISSN: 0975-8585

MRI is useful in detecting intraocular tumours, such as retinoblastoma, which can impair the retina. These tumours can be detected by orbital imaging and their impact on the retina evaluated by an ophthalmologist.

Vascular Abnormalities

MRI can detect vascular abnormalities in the head and neck, and some disorders, such as arteriovenous malformations (AVMs) or aneurysms, can impair blood flow to the retina. These findings have the potential to be critical in understanding the aetiology of retinal ischemia or haemorrhages, particularly after a coincidental injury.

Ocular Coherence Tomography (OCT)

While not an MRI, Optical Coherence Tomography (OCT) is a specialised imaging method used to test the structural integrity of the retina. OCT is used to get high-resolution cross-sectional pictures of the retina.

In conclusion

While MRI is not the primary modality for directly detecting retinal damage, it is critical in diagnosing and comprehending disorders that may affect the retina indirectly. Ophthalmic techniques such as fundus photography, fluorescein angiography, and OCT are preferable for the precise assessment of retinal damage because they provide the best resolution and detailed imaging of the retina itself.

MRI in orbital fractures

Magnetic Resonance Imaging (MRI) is essential in the diagnosis and treatment of orbital injuries. The orbit, the bony socket that houses the eye, is a complicated anatomical structure, and injuries to this region can occur due to a variety of factors such as trauma, infections, tumours, or congenital defects. MRI is a non-invasive imaging method that gives detailed and multiplanar information on the soft tissues within the orbit, making it a great tool for evaluating orbital injuries.

Soft Tissue Evaluation

MRI is excellent in visualising the orbit's soft tissues, such as the extraocular muscles, optic nerve, lacrimal gland, and surrounding connective tissues. This is especially helpful in cases of blunt trauma where these structures may be harmed. Muscle edema, contusions, and even muscle tears and contusions can be detected by MRI.

Magnetic Resonance Imaging (MRI) is essential in the diagnosis and treatment of orbital injuries. The orbit, the bony socket that houses the eye, is a complicated anatomical structure, and injuries to this region can occur due to a variety of factors such as trauma, infections, tumours, or congenital defects. MRI is a non-invasive imaging method that gives detailed and multiplanar information on the soft tissues within the orbit, making it a great tool for evaluating orbital injuries.

Soft Tissue Evaluation

MRI is excellent in visualising the orbit's soft tissues, such as the extraocular muscles, optic nerve, lacrimal gland, and surrounding connective tissues. This is especially helpful in cases of blunt trauma where these structures may be harmed. Muscle edema, contusions, and even muscle tears and contusions can be detected by MRI.

Haemorrhage Evaluation

MRI is very good in detecting and characterising haemorrhage within the orbit, which can occur as a result of traumatic injuries or vascular abnormalities. This data assists in assessing the extent of bleeding, which is important in guiding surgical procedures.

Tumour Detection

Both benign and malignant orbital tumours can masquerade as orbital injuries. By giving comprehensive pictures that highlight the size, location, and characteristics of the lesion, MRI can help distinguish between tumours and traumatic injuries. This is critical for effective treatment planning.

Infection and Inflammatory illnesses

MRI can help visualise the amount of infection and its influence on orbital tissues in situations of orbital cellulitis or other inflammatory illnesses. This data influences the selection of medical or surgical procedures.

While computed tomography (CT) is often the preferred modality for evaluating orbital fractures due to its superior bone visualisation, magnetic resonance imaging (MRI) can still be useful for assessing associated soft tissue injuries, such as muscle or nerve entrapment, which may not be clearly visible on CT scans.

Treatment Planning

The detailed information offered by MRI is useful in orbital injury treatment planning. Surgeons can utilise the images to guide their treatments and make educated decisions about whether surgical intervention or conservative care is required.

Follow-up MRIs can assist monitor the healing process, assess the effectiveness of therapies, and detect any consequences or recurrence of injuries or disorders after therapy [8-10].

To summarise, MRI is critical in the evaluation and therapy of orbital injuries because it provides detailed and multiplanar images of the soft tissues within the orbit. It facilitates in the diagnosis, treatment planning, and monitoring of various orbital diseases, ensuring that patients receive the best and most effective therapy for their unique injuries or difficulties. It is frequently used in concert with other imaging modalities, including as CT, to provide a full assessment of the orbit.

MRI and injuries of optic nerve

Magnetic Resonance Imaging (MRI) is crucial in assessing optic nerve damage, particularly in cases of trauma. . In the examination of optic nerve damage, MRI has various advantages:

Non-Invasive Imaging

Magnetic resonance imaging (MRI) is a non-invasive imaging modality that does not use ionising radiation, making it a safe option for evaluating the optic nerve, which is a sensitive structure.

Soft Tissue Visualisation

Because MRI is so good at visualising soft tissues, it's excellent for evaluating the optic nerve and its surrounding structures. This ability is critical in diagnosing nerve injury and any associated tissue injuries

MRI gives high-resolution, multiplanar pictures of the optic nerve, allowing for a thorough assessment of its size, shape, and integrity. Any abnormalities, such as nerve compression, displacement, or disruption, can be easily identified.

Detection of Haemorrhage and Edema

In cases of optic nerve injury, haemorrhage or edoema might develop. MRI detects changes in tissue density and is sensitive to changes in tissue density, providing useful information for diagnosis and therapy planning.

ISSN: 0975-8585

Differentiating Types of Injury

MRI can assist in distinguishing between various types of optic nerve injury. It can, for example, tell the difference between traumatic injuries like optic nerve avulsion and non-traumatic causes like optic neuritis or tumours. This distinction is critical in directing therapy options.

Injury Localization

MRI can pinpoint the location of an optic nerve injury, whether it happens near the globe (globe-to-nerve injury) or further back along the nerve's path (nerve-to-chiasm injury). This localization is critical for identifying the level of vision loss and planning surgical procedures [11-15].

Evaluation of Related Structures

In addition to the optic nerve, MRI can assess additional orbital components such as soft tissues, extraocular muscles, and bone anatomy. This comprehensive approach is crucial for identifying any secondary damage to the optic nerve or vision.

Treatment Strategy

Following a diagnosis of an optic nerve injury, MRI data inform therapy decisions. Surgical intervention may be required to repair or decompress the nerve, depending on the kind and extent of the lesion.

Long-Term Monitoring

MRI can be utilised for long-term monitoring of optic nerve damage to assess healing progress and therapy success. Follow-up imaging is used to see whether there are any signs of recovery or problems.

In conclusion

MRI is critical in the evaluation of optic nerve damage, particularly in cases of trauma. Its capacity to produce precise images of the optic nerve and adjacent structures, diagnose anomalies, and aid in treatment planning makes it a must-have tool for ophthalmologists, neurologists, and other healthcare professionals caring for patients with optic nerve injuries.

Role of MRI in vitreous injuries

While MRI can be a useful diagnostic technique for evaluating many ocular and orbital diseases, including those involving the eye's surrounding structures, it is not the first choice for examining vitreous injuries or abnormalities [16-19]. To diagnose and treat vitreous-related diseases, ophthalmologists use a combination of clinical examination and specialised imaging techniques like ultrasonography, ophthalmoscopy, and OCT.

MRI's role in corneal injuries

The primary role of MRI in corneal injuries is to identify and localise intraocular foreign entities or to track their probable migration into the eye. The capacity of MRI to provide multiplanar images and its good soft tissue contrast make it particularly useful in distinguishing corneal lesions from surrounding tissues.

The most common use of MRI in ocular injuries is to detect retained metallic foreign materials. MRI might assist ophthalmologists plan surgical procedures by determining the size, location, and depth of penetration. It can also detect potential problems, such as lens or posterior segment involvement.

In corneal injuries, the primary role of MRI is to identify and localise intraocular foreign bodies or to track their probable migration into the eye. Because of its ability to give multiplanar images and strong soft tissue contrast, MRI is very useful in identifying corneal lesions from surrounding tissues.

The most prevalent application of MRI in eye injuries is to detect the presence of retained metallic foreign elements. But the interaction of MRI and metals should be kept in mind. By assessing the size, location, and depth of penetration, MRI may help ophthalmologists plan surgical operations [20-22]. It can also detect possible issues, such as involvement of the lens or posterior segment.

MRI and the lens injury

MRI is typically used to evaluate the tissues surrounding the eye and orbital region, such as the extraocular muscles, optic nerve, and orbital bones. An MRI of the orbit may be performed to check the general ocular state if there is suspicion of a foreign body or other intraocular injuries associated with the traumatic incident, but it is not the preferred modality for directly assessing the lens [23-25]. In conclusion, MRI is not the best imaging tool for assessing traumatic lens damage. To examine and diagnose lens-related injuries within the eye, ophthalmologists use a mix of slit-lamp examination, ultrasonography, anterior segment OCT, and clinical evaluation.

Role of MRI in Iris injuries

Iris injuries are rarely assessed with magnetic resonance imaging (MRI) [26,27]. The iris is a tiny, pigmented structure in the front part of the eye that does not generate the high signals needed for clear visualisation with traditional MRI techniques. MRI is better suited for imaging soft tissues with higher water content, which the iris lacks.

CONCLUSION

Due to the low water content of the eye, MRI has a limited role in direct visualisation of ocular structures, including injuries. Its principal application in ophthalmic injuries is to evaluate accompanying soft tissue, such as extraocular muscles, optic nerves, or orbital bones. MRI aids in the diagnosis of orbital and periorbital diseases, as well as providing context for ocular injuries. Ophthalmic examination, ultrasonography, slit-lamp, and OCT imaging are commonly used to diagnose eye-specific injuries such as lens, iris, or vitreous lesions. MRI, on the other hand, is useful for evaluating the larger impact of ocular injuries on adjacent structures, allowing for a more comprehensive diagnostic and treatment planning.

REFERENCES

[1] van Beek EJR, Kuhl C, Anzai Y, Desmond P, Ehman RL, Gong Q, Gold G, Gulani V, Hall-Craggs M, Leiner T, Lim CCT, Pipe JG, Reeder S, Reinhold C, Smits M, Sodickson DK, Tempany C, Vargas HA, Wang M. Value of MRI in medicine: More than just another test? J Magn Reson Imaging 2019;49(7):e14-e25.
[2] Mafee MF, Karimi A, Shah JD, Rapoport M, Ansari SA. Anatomy and pathology of the eye: role of MR Imaging and CT. Magn Reson Imaging Clin N Am 2006; 14(2): 249-70
[3] Stahl, A.; Hosten, N. Trauma to the Eye: Diffusion Restriction on MRI as a Surrogate Marker for Blindness. Tomography 2023;9:413-419.
[4] Lemke AJ, Kazi I, Felix R. Magnetic resonance imaging of orbital tumors. Eur Radiol 2006;16:2207-19.
[5] Cheng H, Nair G, Walker TA, Kim MK, Pardue MT, Thule PM, Olson DE, Duong TQ. Structural and functional MRI reveals multiple retinal layers. Proc Natl Acad Sci USA 2006;103(46):17525–17530.
[6] Duong TQ, Ngan SC, Ugurbil K, Kim SG. Functional magnetic resonance imaging of the retina. Invest Ophthalmol Vis Sci 2002;43 (4):1176–1181.
[7] Berkowitz BA, Roberts R, Goebel DJ, Luan H. Noninvasive and simultaneous imaging of layer-specific retinal functional adaptation by manganese-enhanced MRI. Invest Ophthalmol Vis Sci 2006;47(6):2668–2674.
[8] Freund M, Hähnel S, Sartor K. The value of magnetic resonance imaging in the diagnosis of orbital floor fractures. Eur Radiol 2002;12(5):1127-33.
[9] Patil SG, Kotwal IA, Joshi U, Allurkar S, Thakur N, Aftab A. Ophthalmological evaluation by a maxillofacial surgeon and an ophthalmologist in assessing the damage to the orbital contents in midfacial fractures: a prospective study. J Maxillofac Oral Surg 2016;15(3):328–335.
[10] Lin KY, Ngai P, Echegoyen JC, Tao JP. Imaging in orbital trauma. Saudi J Ophthalmol 2012;26(4):427-32.

[11] Kanda T, Miyazaki A, Zeng F, Ueno Y, Sofue K, Maeda T, Nogami M, Kitajima K, Murakami T. Magnetic resonance imaging of intraocular optic nerve disorders: review article. Pol J Radiol 2020;85:e67-e81.

[12] Gala F. Magnetic resonance imaging of optic nerve. Indian J Radiol Imaging 2015;25(4):421-38.

[13] Trask W, Mak M, Gohill J, Kherani A, & Subramaniam S. Acute Neuroimaging Findings in Traumatic Optic Neuropathy. Canadian Journal of Neurological Sciences 2023;50(6):937-938.

[14] Gise R, Truong T, Parsikia A, Mbekeani JN. Visual Pathway Injuries in Pediatric Ocular Trauma-A Survey of the National Trauma Data Bank From 2008 to 2014. Pediatr Neurol 2018.

[15] Li Y, Singman E, McCulley T, Wu C, Daphalapurkar N. The Biomechanics of Indirect Traumatic Optic Neuropathy Using a Computational Head Model With a Biofidelic Orbit. Front Neurol 2020;11:346.

[16] Hallinan JT, Pillay P, Koh LH, Goh KY, Yu WY. Eye Globe Abnormalities on MR and CT in Adults: An Anatomical Approach. Korean J Radiol 2016;17(5):664-673.

[17] Mahesh G, Jain A, Bodhankar P, et al. Imaging in posterior segment ocular trauma. Kerala J of Ophthalm 2019; 31(2): 92-101

[18] Lin K, Ngai P, Echegoyen J, et al. Imaging in orbital trauma. Saudi J of Ophthalm. 2012; 26: 427-432

[19] Almousa R, Amrith S, Mani AH, Liang S, Sundar G. Radiologic signs of periorbital trauma – the Singapore experience. Orbit 2020; 29(6): 307-12.

[20] Jolly R, Arjunan M, Theodorou M, Dahlmann-Noor AH. Eye injuries in children - incidence and outcomes: An observational study at a dedicated children's eye casualty. Eur J Ophthalmol 2019;29(5):499-503.

[21] Richard S. Snell, Michael A. Lemp. Clinical Anatomy of the Eye. 2013, ISBN: 9781118691007.

[22] Hallinan JT, Pillay P, Koh LH, Goh KY, Yu WY. Eye Globe Abnormalities on MR and CT in Adults: An Anatomical Approach. Korean J Radiol 2016;17(5):664-673.

[23] Gwyneth A. van Rijn, Jurgen E. M. Mourik, Wouter M. Teeuwisse, Gregorius P. M. Luyten, Andrew G. Webb; Magnetic Resonance Compatibility of Intraocular Lenses Measured at 7 Tesla. Invest Ophthalmol Vis Sci 2012;53(7):3449-3453.

[24] Edward K. Sung, Rohini N. Nadgir, Akifumi Fujita, Cory Siegel, Roya H. Ghafouri, Anastasia Traband, and Osamu Sakai.njuries of the Globe: What Can the Radiologist Offer? Radio Graphics 2014;34(3): 764-776.

[25] Boorstein JM, Titelbaum DS, Patel Y, Wong KT, Grossman RI. CT diagnosis of unsuspected traumatic cataracts in patients with complicated eye injuries: significance of attenuation value of the lens. AJR Am J Roentgenol 1995;164:181-4.

[26] Cheng HM, Yeh LI, Barnett P, Miglior S, Eagon JC, González G, Brady TJ. Proton magnetic resonance imaging of the ocular lens. Exp Eye Res 1987;45:875-82.

[27] Al-Thowaibi A, Kumar M, Al-Matani I. An overview of penetrating ocular trauma with retained intraocular foreign body. Saudi J Ophthalmol 2011;25(2):203-5.