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OLFACTORY DYSFUNCTION AND MRI: DIAGNOSTIC AND THERAPEUTIC INSIGHTS OF CASE SERIES

Otorhinolaryngology

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ABSTRACT

Aim: This study investigates the diagnostic and therapeutic implications of Magnetic Resonance Imaging (MRI) in patients with olfactory dysfunction. The goal is to correlate clinical findings with MRI observations to enhance diagnostic accuracy, guide clinical management, and improve treatment outcomes for diverse etiologies of olfactory loss. **Materials And Methods:** Design and Setting: A retrospective study conducted over one year (June 2023–June 2024) at Sri Siddhartha Medical College and Hospital, Tumkur, Karnataka. Subjects: 46 patients aged 18–80 years with olfactory dysfunction lasting more than six weeks. **Methods:** MRI scans were performed for all participants to assess structural abnormalities in the olfactory pathway. Clinical data were analyzed to identify patterns in etiology, MRI findings, and outcomes. Statistical comparisons were performed for demographic and clinical variables. **Results:** The predominant causes of olfactory dysfunction were sinonasal disorders (46%), post-viral infections (20%), neurodegenerative diseases (13%), head trauma (13%), and intracranial tumors (8%). MRI findings included olfactory bulb atrophy, sinonasal obstructions, and tumor-induced compression. Management strategies ranged from surgical interventions (e.g., functional endoscopic sinus surgery) to olfactory training and symptomatic therapy. Notable improvements in olfactory function were observed in cases of sinonasal disorders and post-surgical tumor resection. **Conclusion:** MRI plays a crucial role in diagnosing and managing olfactory dysfunction by providing high-resolution insights into structural and functional abnormalities. It facilitates the distinction between central and peripheral causes, supporting early intervention and tailored treatment approaches.Future research should explore advanced imaging techniques for enhanced diagnostic accuracy.

KEYWORDS

Olfactory dysfunction, MRI, anosmia, neurodegenerative diseases, sinonasal disorders.

INTRODUCTION

Olfactory dysfunction (OD) is a prevalent yet often overlooked clinical condition that significantly impacts an individual's quality of life, affecting both personal well-being and safety. The sense of smell plays a crucial role in detecting environmental hazards, enhancing flavor perception, and facilitating emotional and social experiences[1]. Consequently, olfactory impairments can lead to substantial psychological distress, nutritional imbalances, and reduced quality of life. Despite its importance, OD remains underdiagnosed and undertreated due to its complex etiology and the limited availability of objective diagnostic tools.

The causes of olfactory dysfunction are diverse, ranging from sinonasal diseases, post-infectious and post-traumatic injuries, neurodegenerative disorders such as Alzheimer's and Parkinson's disease, to idiopathic origins. In particular, post-viral OD has gained significant attention due to the COVID-19 pandemic, which revealed the olfactory system's vulnerability to viral insults[2]. Traumatic brain injuries (TBI) are also a major contributor, as even mild trauma can disrupt the olfactory bulb, tract, or related cortical structures[3]. Neurodegenerative diseases further complicate the picture, as OD often serves as an early non-motor symptom, particularly in Parkinson's and Alzheimer's diseases, preceding other clinical manifestations by years[4].

Magnetic resonance imaging (MRI) has proven to be a valuable tool for evaluating olfactory dysfunction by non-invasive visualization of the olfactory pathway, including the olfactory bulbs, tracts, and central cortical regions such as the orbitofrontal cortex. Structural MRI can detect olfactory bulb atrophy, signal changes, and disruptions along the olfactory pathway, providing valuable insights into the underlying pathophysiology[5].

This case series aims to explore the diagnostic and therapeutic implications of MRI in patients presenting with olfactory dysfunction. By correlating clinical findings with MRI observations, we seek to highlight the role of neuroimaging in improving diagnostic accuracy, identifying underlying etiologies, and guiding clinical management. Ultimately, the insights gained from this study may facilitate early interventions and improve outcomes for patients affected by this often-neglected condition.

MATERIALS AND METHODS

Study Design

A retrospective study was conducted at Sri Siddhartha Medical College and hospital over a period of 1 year (June 2023 to June 2024). Patients presenting with olfactory dysfunction to the ENT department were enrolled. All patients underwent olfactory testing and MRI scans of the brain and/or paranasal sinuses. Clinical data collected from patient records, including demographic, medical history, and MRI findings.

Inclusion Criteria:

1. Diagnosis:
Patients presenting with olfactory dysfunction (e.g., anosmia, hyposmia, or dysosmia) lasting more than 6 weeks.

2. Age:
Adults aged 18 years and older.

3. MRI Imaging:
Patients who underwent MRI of the brain and/or olfactory structures as part of their diagnostic evaluation.

4. Case Completeness:
Cases with complete clinical and radiological data, including MRI results and follow-up information.

Exclusion Criteria:

1. Acute Illness:
Patients with active infections, acute respiratory diseases, or acute head trauma at the time of MRI.

2. MRI Quality:
Poor-quality or incomplete MRI scans that hinder evaluation of the olfactory bulb or other related structures.

3. Comorbidities:
Severe systemic diseases (e.g., advanced cancer, uncontrolled diabetes) likely to affect the olfactory system.

4. Contraindications to MRI:
Patients with implanted medical devices, claustrophobia, or other conditions contraindicating MRI use.

5. Paediatric Cases:
Patients younger than 18 years.

6. Lack of Follow-Up:
Cases without sufficient follow-up data to assess management outcomes.

Data Analysis :
Data were analyzed to identify patterns in etiology, MRI findings, and treatment outcomes. Subgroup analyses were conducted to compare different causes of olfactory dysfunction, including sinonasal disorders, neurodegenerative diseases, trauma, and infections.

Data Collection
- Patient demographics (age, sex).
- Duration and onset of olfactory dysfunction.
- Clinical Examinations findings of patient.
- MRI findings (sinus pathology, olfactory bulb or tract abnormalities, brain tumours, or other central causes).
- Clinical diagnosis based on MRI findings.

RESULTS

Demographics
- Total Patients: 46
- Age Range: 18–80 years (Mean: 55 years)
- Gender Distribution: 26 male (56%), 20 female (44%)
- Olfactory Dysfunction Duration: more than 6 weeks

Aetiologies and MRI Findings
1. Sinonasal Disorders (21 patients, 46%)
Conditions: Chronic rhinosinusitis, nasal polyps, and allergic rhinitis.

Clinical Findings: Patients with sinonasal pathology typically presented with nasal congestion, post-nasal drip, and reduced sense of taste. Olfactory testing confirmed anosmia or hyposmia.

MRI Findings: All 21 patients had bilateral maxillary sinusitis, with nasal polyps obstructing the olfactory clefts. MRI revealed mucosal thickening in the paranasal sinuses but no brain abnormalities. The olfactory bulbs appeared normal in all cases.

Management: All 21 patients underwent functional endoscopic sinus surgery (FESS). Of these, 15 patients reported significant improvement in olfactory function post-surgery.

2. Neurodegenerative Diseases (6 patients, 13%)
Conditions: Parkinson's disease (5 patients), Alzheimer's disease (1 patients).

Clinical Findings: Patients presented with gradual olfactory loss along with signs of neurodegenerative disease such as tremors, rigidity, and cognitive decline in line with presentations of Braak et all[7].

MRI Findings: All patients had bilateral olfactory bulb atrophy. In Parkinson's disease, there was also evidence of substantia nigra degeneration. For Alzheimer's disease, hippocampal atrophy was noted. No sinonasal abnormalities were present.

Management: Olfactory dysfunction in neurodegenerative diseases is often irreversible. Patients were managed with dopaminergic therapy (for Parkinson's) and symptomatic treatment for cognitive decline (for Alzheimer's).

3. Head Trauma (6 patients, 13%)
Conditions: History of motor vehicle accidents or falls resulting in blunt head trauma.

Clinical Findings: Sudden onset of anosmia following head trauma, with some patients reporting memory disturbances or headaches.

MRI Findings: In 4 patients, MRI revealed olfactory nerve disruption and olfactory bulb atrophy. 2 patients had frontal lobe contusions but no direct damage to the olfactory regions.

Management: Most patients received olfactory training. Only one patient showed partial recovery after 6 months of rehabilitation.

4. Viral Infections (9 patients, 20%)
Conditions: Post-viral anosmia following upper respiratory viral infections.

Clinical Findings: Sudden onset of anosmia, typically occurring after a respiratory illness. All patients reported mild to moderate upper respiratory symptoms.

MRI Findings: Mild atrophy of the olfactory bulbs was observed in 3 patients. No sinus pathology was present. MRI was otherwise normal in 6 patients.

Management: All patients underwent olfactory training. 6 patients showed partial recovery of olfactory function, while 3 cases remained unchanged after 6 months.

5. Tumours (4 patients, 8%)
Conditions: Olfactory groove meningiomas (2 patients), gliomas (2 patient).

Clinical Findings: Gradual onset of anosmia with other neurological symptoms such as headaches, personality changes, or cognitive impairment.

MRI Findings: In all cases, MRI revealed well-circumscribed masses in the olfactory groove, compressing the olfactory bulbs and tracts. In one patient with gliomas, MRI showed infiltrative lesions along the olfactory tract.

Management: Surgical resection was performed in all cases. Two patients showed improvement in olfactory function postoperatively, while other two patient did not regain smell due to the extent of tumour invasion.

DISCUSSION

This case series of 46 patients with olfactory dysfunction underscores the importance of MRI in identifying the underlying causes of anosmia and hyposmia. The findings from this study illustrate a diverse range of aetiologies and highlight how MRI can be used to diagnose structural abnormalities affecting the olfactory system.

1. Sinonasal Disorders
Sinonasal disorders were the predominant cause of olfactory loss in this series. MRI is crucial for identifying structural obstructions, such as nasal polyps and sinusitis, which are treatable through surgical interventions. Taha, T et all concluded that MR volumetry and DTI parameters serve as objective tools for assessing olfactory dysfunction in patients with chronic sinonasal polyposis[8]. Rudmik L et al indicated that patients with nasal polyposis and anosmia are more likely to experience olfactory improvement after ESS, whereas those with hyposmia but no nasal polyposis have a reduced likelihood of improvement[9].

2. Neurodegenerative Diseases
Conditions like Parkinson's disease (PD) and Alzheimer's disease (AD) are closely associated with olfactory bulb atrophy and dysfunction. Olfactory dysfunction often presents in the prodromal phase of neurodegenerative diseases, and MRI can detect olfactory bulb atrophy, supporting early diagnosis and intervention. Furthermore, MRI can identify lesions in central olfactory pathways, such as strokes or demyelinating diseases (e.g., multiple sclerosis), that impair olfactory processing. Huang P et all suggested that in neurodegenerative diseases, brain damage progresses gradually, often requiring an extended period for noticeable macroscopic changes to develop, emphasizing the need for imaging with higher resolution.[10].

3. Head Trauma
Head trauma frequently leads to olfactory nerve injury and is a significant cause of anosmia and hyposmia. MRI is effective in visualizing trauma-related damage to the cribriform plate, olfactory bulb, and olfactory tracts. It also helps detect associated complications, including cerebrospinal fluid leaks and intracranial hemorrhages.

Olfactory training can improve the olfaction in patients with posttraumatic olfactory dysfunction within 8 months with a recovery rate of 36.31% according to results of Huang T et all[11].

4. Viral Infections

Viral infections, including COVID-19, are significant contributors to post-viral olfactory dysfunction. MRI studies have demonstrated subtle structural changes, including mild olfactory bulb atrophy, following viral infections. Signal changes in the olfactory bulb and tracts can also be observed, particularly in COVID-19 patients. Longitudinal MRI studies are valuable for tracking changes in the olfactory bulb and correlating them with clinical recovery during follow-up. Lechien et all concluded that following an olfactory training protocol was linked to significant mid-term improvements in psychophysical scores among patients with olfactory dysfunction (OD)[12].

5. Intracranial Tumours

Intracranial tumours, including olfactory groove meningiomas, are associated with localized olfactory dysfunction. MRI provides critical insights into tumour size, location, and involvement of adjacent structures, guiding surgical intervention there by contradicting the findings of Tung IM et all[13]. It is also instrumental in differentiating neoplastic causes from inflammatory or infectious processes, ensuring timely referral for oncology or surgical management .

CONCLUSION

This case series highlights the diagnostic and therapeutic relevance of magnetic resonance imaging (MRI) in understanding olfactory dysfunction. By correlating clinical findings with MRI observations, our study emphasizes the utility of neuroimaging in identifying structural and functional abnormalities of the olfactory pathway, particularly in cases where conventional diagnostic tools yield inconclusive results.

The olfactory system's complexity presents challenges in pinpointing the precise cause of dysfunction, whether due to neurodegenerative diseases, trauma, infection, or idiopathic origins. Through detailed MRI analyses, we observed alterations such as olfactory bulb atrophy, signal changes in the olfactory tract, and cortical disruptions. These findings not only corroborated the clinical manifestations of olfactory dysfunction in our patients but also underscored the role of MRI as a non-invasive, reliable modality for anatomical and functional assessment. Specifically, MRI imaging provides critical insights into the integrity of the olfactory bulbs and related neural structures, which can guide clinicians in differentiating between central and peripheral causes of olfactory dysfunction.

Early detection of structural changes may enable prompt interventions that improve patient outcomes. For example, rehabilitation strategies such as olfactory training can be initiated earlier in cases of post-viral or post-traumatic olfactory dysfunction, where neuroplasticity offers the potential for recovery. In addition, MRI findings can help identify patients with underlying neurodegenerative processes, such as Alzheimer's or Parkinson's disease, thereby facilitating early disease-modifying interventions and improved prognostic evaluations.

Despite its advantages, MRI in olfactory dysfunction assessment is not without limitations. Variability in imaging protocols and interpretation, as well as the cost and accessibility of MRI, may pose challenges for routine clinical use. Nevertheless, advancements in imaging technologies and increased awareness among clinicians are likely to mitigate these challenges in the future.

In conclusion, this case series demonstrates that MRI is an invaluable tool in the diagnosis and management of olfactory dysfunction. By providing detailed structural insights, MRI aids in identifying underlying etiologies, improving diagnostic accuracy, and guiding therapeutic decisions. Future research incorporating larger cohorts and advanced imaging techniques, such as functional MRI or diffusion tensor imaging, may further enhance our understanding of olfactory dysfunction and its broader implications in neurological health. Ultimately, integrating MRI into the diagnostic algorithm for olfactory dysfunction holds promise for personalized and targeted patient care.

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