**Assessment of Accommodative Changes in Myopic Patients with Asthenopic Symptoms: A Prospective Observational Study**

**ABSTRACT**

**Background:** Myopia is a widespread refractive error characterized by an inability to clearly see distant objects due to the eye’s axial length being longer than normal or its refractive components being too strong. This condition can lead to asthenopia—symptoms such as eye strain, headache, and blurred vision—especially during prolonged near tasks. While refractive correction alleviates symptoms for many, some patients continue to experience discomfort due to undiagnosed accommodative anomalies. This study aims to evaluate accommodative dysfunctions in untreated myopic individuals presenting with asthenopic symptoms. **Methods:** A prospective observational study was conducted at an urban tertiary eye care center in North India. Ninety-eight subjects aged 18–39 years with untreated myopia and asthenopic symptoms were included. All underwent refraction and a full orthoptic workup including negative and positive relative accommodation (NRA, PRA), near point of accommodation (NPA), monocular estimated method (MEM), and other binocular function tests. Glasses were prescribed based on refraction results, and patients were reassessed after six weeks to evaluate symptom resolution. Persistent cases were investigated for accommodative insufficiency (AI) or accommodative excess (AE). **Results:** Among the 98 participants, 56 were female and 42 were male, with a mean age of 24.13 ± 6.22 years. Distribution of refractive errors showed that 23% had simple myopia (SM), 5% moderate myopia (MM), 43% simple myopic astigmatism (SMA), and 29% compound myopic astigmatism (CMA). After spectacle correction, 26.53% of participants reported symptom relief. However, 73.47% continued to have symptoms and were found to have accommodative dysfunction—43.88% had AI and 29.59% had AE. SMA patients had the highest AI prevalence. **Conclusion:** Accommodative dysfunctions are significantly prevalent in untreated myopic individuals with asthenopic symptoms, particularly in those with astigmatic components. Comprehensive accommodative evaluation should be a routine component of optometric examination in symptomatic myopic patients, even after refractive correction.

**Keywords:** Myopia, Asthenopia, Accommodation, Accommodative Insufficiency, Accommodative Excess, Myopic Astigmatism, Accommodative, Myopic, Asthenopic

**INTRODUCTION**

Refractive errors constitute one of the most common causes of visual impairment globally, with myopia being among the most prevalent forms. Myopia, also known as shortsightedness, is characterized by the focal point of parallel light rays falling anterior to the retina when the eye’s accommodation is at rest. This results in clear vision for near objects but blurred vision for distant objects, significantly affecting daily functioning and quality of life. The increasing prevalence of myopia has become a major public health concern, particularly among younger populations engaged in near work activities. Over the past 20 years, there has been a notable global rise in the prevalence of myopia. Data from the Brien Holden Vision Institute indicate that the global myopia rate climbed from 23% in the year 2000 to around 34% by 2020, and it is projected to exceed 40% by 2025, potentially impacting over 2.6 billion individuals worldwide. Significant regional variations exist, with East Asia experiencing the highest rates—urban areas report that nearly 80% of children are affected. In South Asia, the prevalence has grown from 15% in 2000 to nearly 30% by 2020, with estimates suggesting a further increase to 35% by 2025. Similarly, industrialized nations such as the United States and various European countries are seeing rising trends, with rates nearing 50%. In India, the prevalence of myopia among urban children has increased significantly from approximately 4.4% in 1999 to 21.1% in 2019, with projections suggesting it may reach around 32% by 2030. Specifically, in Uttar Pradesh, school-based studies report a myopia prevalence of about 16.4% among children aged 8–16 years, and 11.5% among adults over 19 years, with estimated rates expected to rise to approximately 20–21% by 2025 in line with national trends. This upward trend is largely linked to lifestyle changes, including greater time spent on near-vision tasks such as screen use and reduced outdoor activity. [1] Myopia can be classified into different categories based on the degree of refractive error. Simple myopia refers to refractive errors ranging from -0.25 diopters (D) to -3.00 D spherical equivalent. Moderate myopia includes refractive errors between -3.25 D and -6.00 D, while high myopia is classified as refractive errors greater than -6.25 D spherical equivalent. Each category presents unique challenges in terms of management, progression risk, and associated ocular complications.[2]

Additionally, myopic astigmatism is a common subtype of refractive error characterized by varying refractive power across different meridians of the eye, leading to blurred or distorted vision. It is further divided into simple myopic astigmatism, where only one meridian is affected, and compound myopic astigmatism, where both principal meridians have myopic refractive error but differ in their curvature. The pathophysiology of myopia and myopic astigmatism is multifactorial, involving alterations in axial length (axial myopia), corneal curvature, and lens shape. Changes in these anatomical structures influence how light is focused on the retina, contributing to the degree and type of refractive error. [3]

The etiology of myopia is complex, involving both genetic predisposition and environmental influences. Family history plays a significant role in the likelihood of developing myopia; however, lifestyle factors have garnered increasing attention, especially with the rise in near work activities such as prolonged reading, computer use, smartphone engagement, and video gaming. Studies suggest that excessive near work, especially with digital devices, increases the risk of myopia development by approximately 30%, and this risk may escalate to as high as 80% with continuous and intensive screen time. This is particularly concerning in the modern era, where children and young adults spend increasing hours on electronic devices, potentially exacerbating the global myopia epidemic. [4,5,6]

Patients with myopia often present with common complaints such as blurred distance vision and the need to hold reading materials closer to the eyes. Those with myopic astigmatism may experience additional symptoms like ocular pain, eye strain, and headaches, especially during prolonged near tasks. These symptoms are collectively referred to as asthenopic symptoms and are indicative of underlying accommodative or binocular vision anomalies. Accommodative insufficiency, where the ability of the eye to focus on near objects is reduced, and accommodative excess, characterized by excessive and often spasmodic accommodation, are frequently implicated in the development of such symptoms.[7,8]

Accommodation is a dynamic process by which the crystalline lens changes shape to focus on objects at varying distances. This process involves contraction and relaxation of the ciliary muscles, affecting the tension on the zonules of Zinn and altering the curvature of the lens. [9,10] Anomalies in accommodation can lead to visual discomfort and symptoms commonly encountered in patients with refractive errors, especially myopia. Accommodative insufficiency is often caused by fatigue, uncorrected refractive errors, or ciliary muscle dysfunction, whereas accommodative excess may be related to muscle spasm or convergence insufficiency. [11]

Diagnosis of accommodative anomalies requires a comprehensive assessment including refractive correction, cover testing, measurement of near point of accommodation (NPA), monocular estimated method (MEM) retinoscopy, accommodative facility testing, and evaluation of positive and negative relative accommodation (PRA and NRA). Management strategies focus on correcting refractive errors, vision therapy exercises (such as Brock string and accommodative flippers), and lifestyle modifications to reduce strain, including minimizing screen time and improving ambient lighting during near work.[12]

Given the increasing prevalence of myopia and its associated visual symptoms, especially in the context of modern lifestyle factors, it is essential to understand the accommodative changes in untreated myopic individuals presenting with asthenopic symptoms. This understanding aids in more effective diagnosis and management, improving patient outcomes and reducing visual discomfort. [13]

This study aims to assess accommodative changes in untreated myopic patients presenting with asthenopic symptoms, categorizing myopia into simple, moderate, and high myopia, along with simple and compound myopic astigmatism. By correlating refractive error types with accommodative dysfunctions, the study seeks to provide insights into the clinical management of myopic patients experiencing visual fatigue.

**MATERIALS AND METHODS**

This prospective observational study was conducted in a clinical setting in New Delhi and involved a total of 98 subjects diagnosed with myopia presenting with asthenopic symptoms. The study population included both males and females aged between 18 and 39 years, with an approximately equal gender distribution. All participants were selected based on specific inclusion and exclusion criteria to ensure the reliability and relevance of the findings. The inclusion criteria comprised adults aged 18 to 39 years with a confirmed diagnosis of myopia or myopic astigmatism and experiencing asthenopic symptoms such as eye strain, headache, or visual discomfort. Participants were also required to be previous spectacle users to ensure familiarity with refractive correction. Individuals with ocular diseases, history of ocular trauma, neurological or systemic illnesses affecting ocular health, and those outside the specified age range were excluded from the study.

The refractive errors of the participants were categorized into five groups: simple myopia (SM), moderate myopia (MM), high myopia (HM), simple myopic astigmatism (SMA), and compound myopic astigmatism (CMA). Simple myopia was defined as a spherical equivalent between -0.25 D and -3.00 D, moderate myopia between -3.25 D and -6.00 D, and high myopia as greater than -6.25 D. Simple myopic astigmatism referred to myopia affecting a single meridian, while compound myopic astigmatism involved myopic refractive error in both principal meridians with differing curvatures.

Participants underwent a comprehensive orthoptic workup, which included measurement of visual acuity using standardized distance vision charts, objective and subjective refraction assessments with retinoscopy and trial lenses, and accommodative function testing. The accommodative assessment comprised several standardized tests to evaluate different parameters of accommodation. Near point of accommodation (NPA) was measured using the Royal Air Force (RAF) rule, which determines the closest point at which the subject can maintain a clear image. The monocular estimated method (MEM) retinoscopy was performed to evaluate accommodative response accuracy. Additionally, negative relative accommodation (NRA) and positive relative accommodation (PRA) were assessed to understand the flexibility and range of accommodation under binocular viewing conditions.

All subjects were initially prescribed appropriate corrective spectacles based on their refractive error. After a six-week adaptation period wearing the prescribed correction, participants were asked to return for follow-up evaluation. During this follow-up, if asthenopic symptoms persisted, a detailed orthoptic examination was repeated to identify any accommodative anomalies. These anomalies were classified into accommodative insufficiency (AI) or accommodative excess (AE) based on the results of the accommodative tests.

Data collected during the study, including refractive error category, accommodative test results, and symptomatology, were systematically recorded in an Excel spreadsheet for further analysis. Ethical approval was obtained prior to study commencement, and informed consent was secured from all participants after providing detailed information about the study objectives and procedures.

The study focused on correlating the type of myopia and presence of asthenopic symptoms with specific accommodative changes. The data were analyzed to determine the prevalence of accommodative insufficiency and excess among the different myopic subgroups, thereby enhancing understanding of the accommodative dysfunctions commonly associated with myopia and myopic astigmatism in symptomatic patients.

**RESULTS**

**Demographics and Refractive Distribution**

Of the 98 participants, 56 (57.14%) were female and 42 (42.86%) were male. The age range was 18–34 years, with a mean age of 24.13 years (SD ± 6.22). Participants were categorized into four refractive subtypes based on spherical and cylindrical components.

**Table 1: Refractive Error Distribution**

|  |  |  |
| --- | --- | --- |
| **Refractive Type** | **Frequency (n=98)** | **Percentage (%)** |
| Simple Myopia (SM) | 23 | 23.00% |
| Moderate Myopia (MM) | 5 | 5.00% |
| Simple Myopic Astigmatism (SMA) | 42 | 43.00% |
| Compound Myopic Astigmatism (CMA) | 28 | 29.00% |

The highest proportion of patients (43%) presented with simple myopic astigmatism, indicating a notable burden of astigmatic error in this population.

**Post-Correction Symptoms and Accommodative Changes**

After 6 weeks of spectacle wear:

* 26.53% (n=26) reported complete symptom relief
* 73.47% (n=72) continued to experience asthenopic symptoms

Further accommodative testing of these 72 symptomatic patients revealed:

* 43.88% (n=43) had Accommodative Insufficiency (AI)
* 29.59% (n=29) had Accommodative Excess (AE)
* 26.53% (n=26) had No Anomaly (NA)

**Table 2: Accommodative Status by Refractive Type**

|  |  |  |  |
| --- | --- | --- | --- |
| **Refractive Type** | **AI (%)** | **AE (%)** | **No Anomaly (%)** |
| SM | 39.13 | 43.48 | 17.39 |
| MM | 40.00 | 20.00 | 40.00 |
| SMA | 52.38 | 23.81 | 23.81 |
| CMA | 35.71 | 28.57 | 35.71 |

The SMA group showed the highest proportion of AI (52.38%), highlighting a possible correlation between irregular astigmatism and accommodative fatigue.

**DISCUSSION**

This study evaluated the presence of accommodative dysfunctions—specifically accommodative insufficiency (AI) and accommodative excess (AE)—in untreated myopic individuals presenting with asthenopic symptoms. Our findings reveal a substantial prevalence of accommodative anomalies in this population, even after appropriate spectacle correction, underscoring the multifactorial nature of visual fatigue and discomfort.

A total of 73.47% of participants continued to experience symptoms after refractive correction, with 43.88% diagnosed with AI and 29.59% with AE. Notably, simple myopic astigmatism (SMA) was the most affected refractive group, followed by compound myopic astigmatism (CMA), suggesting that individuals with cylindrical refractive components are more susceptible to accommodative anomalies.

Our results suggest that a significant proportion of symptomatic myopic individuals have underlying accommodative dysfunctions that are not addressed by refractive correction alone. This is consistent with the physiological understanding that sustained near work, especially in uncorrected or under-corrected myopia, can strain the accommodative system. AI is often associated with symptoms like blurred near vision, fatigue, and headache, while AE is linked to difficulty relaxing focus when shifting to distance viewing.

The high prevalence of AI in the SMA group (52.38%) may be due to unequal optical focus across meridians, causing continuous accommodative micro-adjustments. Such adjustments may fatigue the ciliary muscle over time, particularly during tasks requiring prolonged near focus, such as reading or screen use. Similarly, AE found in 28.57% of CMA cases may relate to ciliary muscle overexertion from attempting to overcome the astigmatic blur, especially in patients engaging in digital device use for extended periods.

The impact of near work is particularly noteworthy. Many patients reported extended screen exposure due to professional or academic requirements, often without adequate breaks. This aligns with existing literature suggesting a strong correlation between digital screen use and accommodative strain, especially in younger populations who are more reliant on smartphones and computers.

Our findings complement and expand upon previous research in this area. Gwiazda et al. (1993) demonstrated that myopic children exhibited insufficient accommodative response to negative lenses, suggesting a weakened or lagging accommodative mechanism. While their focus was on pediatric patients and emmetropic comparisons, our study narrows in on symptomatic adult myopes and still identifies a high incidence of accommodative dysfunction, reinforcing that this issue persists beyond childhood. [2]

Mutti et al. (2006) explored the lag of accommodation before and after the onset of myopia, reporting no significant differences. However, their methodology did not directly evaluate AI or AE, and the emphasis was on longitudinal development rather than symptomatic relief. Our work adds value by emphasizing the clinical manifestation of accommodative anomalies in symptomatic individuals rather than tracking accommodative lag alone.[3]

Trine Langaas et al. (2008) also evaluated variability in accommodative response and pupil size but found no significant differences in response between myopes and emmetropes. These differences in outcomes may arise from population characteristics, methods, or the specific symptomatic criteria applied in our study, which focused exclusively on individuals presenting with asthenopic complaints. In fact, one of the unique contributions of this study is that it isolates a clinically relevant group—symptomatic, untreated myopic adults—making the results highly applicable in daily optometric practice. [4]

**Clinical Implications**

These results highlight the importance of going beyond simple refractive correction when managing patients with myopia and visual discomfort. Even when best-corrected visual acuity is achieved, residual symptoms may persist due to unaddressed accommodative anomalies. This necessitates the integration of orthoptic testing in routine optometric and ophthalmic examinations, particularly in younger adults and students who report eye strain or headaches despite recent spectacle correction.

Management of these anomalies may include:

* **Vision therapy:** Exercises to strengthen accommodative facility and flexibility.
* **Low plus lens additions** for near work in cases of AI.
* **Cycloplegic therapy** or near-point stress management in cases of AE.
* **Lifestyle modifications**, including structured screen time and 20-20-20 rule adherence.

In clinical settings, early diagnosis and intervention can reduce the risk of chronic discomfort, enhance academic/work performance, and prevent misdiagnosis of symptoms as being psychogenic or neurological in origin.

**Conclusion**

The study underscores the high prevalence of accommodative dysfunctions in untreated myopic patients presenting with asthenopic symptoms. While refractive correction remains the first line of management, optometrists must be vigilant in evaluating accommodation, especially in those with persistent symptoms. Routine use of accommodative tests, including NPA, NRA, PRA, and MEM, is recommended in symptomatic patients. Visual hygiene practices, near-work moderation, and specific accommodative therapies like flipper exercises or plus lens therapy should be considered as adjuncts.

**Limitations**

While our study offers important insights, it is not without limitations:

* **Sample size** was modest (n=98), and larger multicentric studies could validate the prevalence rates further.
* **Age group restriction (18–39 years)** limits generalizability to pediatric and older populations. Children and adolescents, who have a higher risk of myopia progression, may exhibit different accommodative patterns.
* **Absence of control groups** (e.g., emmetropic or hyperopic individuals) means we cannot directly compare rates of accommodative dysfunction across refractive types.
* **Symptom quantification** was qualitative; future studies may benefit from validated symptom questionnaires (e.g., the Convergence Insufficiency Symptom Survey - CISS).
* **Environmental and behavioral data** (e.g., hours of near work, digital device use) were not quantified but could influence results.
* **No dynamic retinoscopy or objective lag assessment tools** (like open-field autorefractors) were used, which could have added more precision in diagnosing accommodation anomalies.

**Future Directions**

Future research could consider:

* Investigating pediatric populations where accommodation plays a role in myopia development and progression.
* Comparative studies involving emmetropes, hypermetropes, and different levels of myopia.
* Longitudinal follow-up to assess whether managing accommodative dysfunction reduces the risk of myopia progression.
* The role of digital device overuse and environmental lighting in accommodative fatigue.

**Ethical Approval and Consent:**

Informed consent was obtained from all participants. The study protocol adhered to the tenets of the Declaration of Helsinki and was approved by the institutional ethical review board.

**Disclaimer (Artificial intelligence)**

Option 1:

NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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