Clinical Pediatric Ophthalmology and Strabismus

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Foreword
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JAYPEE

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CHAPTER

Accommodative Anomalies in Children

Yogesh Shukla

INTRODUCTION

Accommodation is one of the greatest virtues we use to see clearly and comfortably. There are quite a number of visual problems which arise while using the eyes for near work, where accommodation comes into effect; but unfortunately, this aspect has been least studied and even disregarded. Ocular asthenopia and host of related problems arising on near work, have never been addressed scientifically and attributed to anomalies in accommodation. More so, such problems have never been even thought to arise in children as their accommodation is assumed to be great and flawless. This is a big misbelief which we have nurtured for all along. Though this concept has been studied for many years and we have now a clear understanding of the accommodative mechanism, but it is rarely clinically applied in practice. Symptoms on near work such as headaches, asthenopia, watering, blurring, redness, lack of concentration, etc., occur frequently in children, and every test is done from refraction to ocular motility to find the cause, except accommodative tests.

The knowledge of how the neuronal accommodative system functions is still limited. The general consensus that young children or teenagers, with strong accommodative amplitudes are immune to accommodative anomalies, is misleading. Way back in 1912, Duane stated that the amplitude of accommodative is quite high in young children. Since then, for almost a century, it has been universally approved that accommodation in young children is extremely flexible and resistant to fatigue. Though this old data is still what we normally believe, the ocular accommodation in children is not as sufficient or efficient as we expect. There is no simple standard procedure which includes all accommodative facets for examination. The accommodative system is therefore, not routinely examined because of lack of such method and more so because of the concept that there cannot be any fallacy of accommodation in children. Young school children may have an insufficient accommodative ability that causes subjective symptoms when reading. Excluding all pathological or pharmaceutical entities, a "general weakness" in a child is enough to cause near work dysfunctions. Therefore, it is prudent and mandatory to look carefully and seriously into any complaints arising out of near work in children.

A proper cycloplegic refraction is primary to all complaints, whether or not the visual acuity is normal. After a correct lens prescription, if the complaints persist, then a thorough accommodative tests should be performed. Accommodative spasm is not infrequent in an uncorrected hyperope, especially if the person is involved in excessive, long near work as in computer work. The ordeal of "computer vision syndrome" is now well documented. But, we rarely go into the tests for accommodative anomalies arising in this syndrome.

But, it may come as a surprise that accommodation is not as efficient in children as expected. Number of studies have now clearly stated that in case of above symptoms, a thorough accommodative tests should also be carried out. Subjective symptoms usually emerge around 6–7 years of age, when children start getting extensively involved in near work, and there is a clear relation between accommodative parameters and these symptoms. Because accommodative dysfunctions may result in varied visual and asthenopic symptoms, it is of utmost importance to identify this dysfunction to prevent unnecessary visual problems. Therefore, clear standards for diagnosing an accommodative dysfunction need to be further refined. Studies have shown that accommodative training, in cases of dysfunction, is an effective method in alleviating the symptoms.

BASICS OF ACCOMMODATION

- Anatomically, three parts in the eye are involved in the accommodative process, i.e., (1) ciliary muscles-circular and meridional, (2) the zonules, and (3) the crystalline lens.

  By far, most of attention has been through a single window—the lens in the accommodative mechanism; very little focus has been given to the muscles which are the primary partner in this process. It is now becoming evidently clear that accommodative anomalies, especially in children, are primarily situated in the muscles.
- The characteristics of effective "accommodative stimuli" is the first step in our understanding of accommodative system. There are a number of "different" accommodative

stimuli which stimulate accommodation to varying degrees. These are:

- Blur of the object
- Proximity of the target
- Changing target size
- Chromatic aberration
- Convergence of eyes
- Spatial frequency.

These are all different stimuli to accommodation with "Blur" of object having the greatest impact as stimuli, though independent of visual acuity.

An important implication is the completely different character of these stimuli which can act together as well as independently.

AMPLITUDE OF ACCOMMODATION

The ability to focus a visual target at varying distances is known as accommodation and is present to some extent from birth, but improves rapidly by first 6 months of life. It is believed that a small child is able to focus from infinity down to very close to the eyes because of high level of accommodation. However, it is to be noted that accommodation and convergence are not automatically linked from the start. The amount of accommodation in diopters, needed to clearly focus an object from infinity to the nearest point possible, is the "amplitude of accommodation".

The accommodative function is normally expressed by describing the accommodative amplitude and its dioptric value. However, the accommodative function is more complicated than that. The accommodative system is complex and comprises of not only the amplitude but number of other functions; any of them can be underdeveloped and can give rise to ocular symptoms. Therefore, the object of this article is to apprise the reader of various facets of accommodative system and the implications it has on the subjective symptoms in a child.

DIFFERENT FACETS OF ACCOMMODATION

- Amplitude of accommodation
- Tonic accommodation (TA)
- Lag of accommodation
- Convergence accommodation
- Accommodative facility
- Relative accommodation.

These facets differ greatly from each other with regard to function. They require different methods of measurement and are not explained by the same dioptric value. There is no method in use that describes the complete accommodative function nor we use the same measuring system for different dioptric results. Furthermore, dysfunction of each envisages different set of symptoms.

Let us review each of these facets.

- *Amplitude of accommodation:* As already stated, it is the total accommodative power of the eye and is expressed in dioptric equivalent and is reciprocal to the distance of the object from the eye. As age advances, the power of accommodation deteriorates, and the ability to see clearly at near diminishes. As a matter of fact, this ability or facet of accommodation, is most relevant to the clinician and thus is the only one tested clinically in routine practice.

  Amplitude tests:

  - *Donders push-up method:* This uses the Royal Air Force (RAF) ruler (also known as prince ruler). In this, a ruler about 50 cm in length has markings on one side in cms and other side in diopters. A sliding box is mounted on the ruler in which letter lines conforming to Snellens optotype size to be read from near. The subject holds the ruler with one end mounted on nose and holds the other end with the hand. A +3.0 D lens is placed in front of eyes to pull up the range of accommodation to 35 cm. The reading card or box is moved away till the print blurs and pulled up near till the print blurs again. The difference between the two readings gives the amplitude of accommodation.
  - *Sheard's method:* Here, minus lenses are added at far distance target, monocularly or binocularly, until blur at distance occurs. The power of lenses used, gives the amplitude.
- *Tonic accommodation:* Tonic accommodation or dark accommodation (DA) is a passive state of accommodation in the absence of any stimulus. This occurs when the eye is in complete darkness or when it is looking at a bright empty field. Basically, it is the inherent tone of the ciliary muscles when the eye at rest. Ironically, the resting "tone" varies in different situations or differs in refractive errors. This tonic state of accommodation or the "resting state tone" of the ciliary muscles can be unearthed only after total cycloplegia. Another way of measuring is by using an objective "infrared optometer".
- *Lag of accommodation:* The amount by which the accommodative response of the eye is less than the dioptric stimulus to accommodation is defined as the "accommodative lag". Clinical measurement of accommodative lag at near is typically done by dynamic retinoscopy. This is an objective method in which the patient views a near point target, while the examiner uses lenses to neutralize the fundal glow.
- *Convergence accommodation:* Convergence accommodation is normally described by the ratio between convergence-accommodation and convergence, or the CA/C ratio. The ratio is the measure of the effect of change in convergence on accommodation. It is expressed as the change in accommodation (Diop.) for each change in convergence in prism D.
- *Accommodative facility:* "Accommodative facility" is the ability to rapidly change the power of the crystalline lens to various focus distances while maintaining a requisite angle of convergence (binocularly) or eliminating the

influence of convergence (monocularly). This ability is important while changing the fixation from near to distance and back again.

Clinically, accommodative facility can be measured using lenses that stimulate accommodation (minus lenses) or inhibit accommodation (plus lenses). Any combination can be used for evaluation, but experience has shown that ±2 D is a reasonable choice. The procedure uses ±2 D lens pair mounted on a "flipper frame". A flipper is a frame on which two plus and two minus lenses are mounted **(Fig. 1)**. The subject focuses through one pair of lenses at an object at fixed distance (say 40 cm). When the object is clearly focused, a "flip" of the frame is quickly performed to bring the other pair in front of eyes, and the person focuses through them. This is then again repeated; and the number of cycles completed in 1 minute is noted as the "accommodative facility" in "cycles/min" (cpm).

Normative data on children have been collected by number of researchers. The results of the flipper test in children aged 6–12 years were 5.0 ± 2.5 cpm, in one study and 4.0 ± 2.5 cpm in another study.

The cutoff parameter for reduced facility to show symptoms is <3 cpm.

The facility testing is important and has bearing on the symptoms where children complain in difficulty in focusing on the board and then reading/writing at near.

- *Relative accommodation:* The total amount of accommodation which can be exerted while the convergence remaining fixed is called the "relative accommodation". This can be either "positive relative accommodation (PRA) or negative relative accommodation (NRA)." PRA is the amount of accommodation in excess of the accommodation needed for convergence and NRA is the amount of accommodation less than needed for convergence. In other words, the least amount of accommodation or maximum relaxation of accommodation with which one can see clearly at a fixed distance is the NRA and the maximum accommodation used over and above the need at a fixed distance is called PRA. To assess this flexibility, a simple test is used. With a vergence stimulus fixed at 40 cm, positive lenses with 0.25 D increment are put in front of both eyes and the first sign of blur is noted. The amount of plus lenses used will give the value of NRA. Similarly, now minus lenses are used with increasing power in 0.25 D steps, binocularly, till the first sign of blur is noted. The increased amount of stimulus at this point is the PRA.

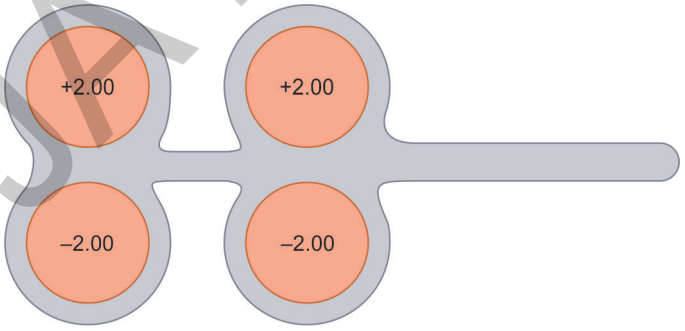

Fig. 1: Flipper frame.

Tests for PRA and NRA are very helpful in determining accommodative dysfunctions in children. A low NRA reveals accommodative spasticity; while a low PRA suggests that the focusing mechanism may be prone to tiring after concentrated near work.

It would be not out of place to discuss about the accommodative convergence/accommodation ratio (AC/A) ratio; as it is linked with accommodation. Due to the near vision reflex complex, a certain amount of convergence is expected when accommodation is in force. The relation between the dioptric change in accommodation and the prismatic change in convergence is called the AC/A ratio. In simple terms, the AC/A ratio describes how much convergence is activated by an accommodative change of 1 D. Normally a convergence of 3–5 PD occurs when 1 D of accommodation is exerted. An AC/A of 10 or more is termed as high ratio while an AC/A ratio of <3 is termed as low.

Tests for PRA and NRA are very helpful in determining accommodative dysfunction. A low NRA reveals accommodative spasticity; a low PRA, on the other hand, suggests that the focusing system is prone to tiring after concentrated near work.

PRACTICAL DYSFUNCTIONS

The accommodative system at young age is quite flexible and resistant to fatigue. However, in clinical practice, accommodative dysfunction can occur in children and young people. Often children and teenagers complain of certain symptoms which appear when doing near work. The refractive system is usually emmetrope or slightly ametropic, but that is not always in relation to the complaints. Unfortunately, there does not exist, as mentioned earlier, no simple, single standard procedure which might include all facets of accommodative dysfunction. Because of this reason and because we do not have any clear cut method of treating accommodative problems, the accommodative system is not routinely examined. But, it is of great importance to identify any accommodative dysfunction, if any complaints exist, so that unnecessary near vision problems may be prevented. It is also important to identify any accommodative dysfunction or deficiency in school going children, because this has a bearing on the performance of children in school. Because the focusing system of eyes has contribution in the learning process, any accommodative deficiency can make it unnecessarily difficult for the child to read and write and develop in studies. If the child's accommodative deficiencies are not resolved, he/she may develop dislike any near work

and develop lack of interest in studies. Therefore, we need to find a simple and easy-to-use method that identifies an accommodative dysfunction.

It is difficult to group together accommodative dysfunctions, as the boundaries are often unclear. However, clinically it is useful to separate anomalies of accommodation into five distinct syndrome categories:

1. Insufficiency of accommodation
2. Infacility of accommodation
3. Fatigue of accommodation
4. Spasm of accommodation
5. Paresis of accommodation

These five syndromes constitute different accommodative disorders, having slightly different symptoms, having different impact on accommodative function.

A brief description of each would be helpful in identifying and treating the disorders.

An important aspect is that of symptoms related to accommodative dysfunction must be clearly recognized and understood. Most of times, the clinician concentrates only on the refractive anomalies and attributes all symptoms to the refractive problem. It should be remembered that all symptoms need not be due to refractive error; time should be devoted to enquire about all symptoms specially arising from near work and tests should be employed to determine the type of accommodative anomaly.

Understanding the symptoms is of paramount importance in recognizing any accommodative anomaly.

Asthenopia is a cardinal symptom which stands out prominently in accommodative deficiencies. Asthenopia is a term used to describe eye-strain or symptoms arising from use of eyes for near work.

Though asthenopia is used loosely to describe all types of symptoms but scientifically explaining, it means purely eye strain and comprises of red eyes, frequent rubbing and irritation of eyes, and disinterest in doing near work after a certain time. Other symptoms arising of accommodative strain are headaches, diplopia, blurring, vertigo, and drowsiness.

As asthenopia is the flagbearer of any ocular morbidity, it would be not out of place to illustrate the reasons of asthenopia. Asthenopia, per se, can occur in the following conditions:

- Accommodative insufficiency
- Accommodative infacility
- Accommodative fatigue
- Accommodative spasm
- Dyslexia
- Hysteria
- Ocular inflammations
- Phorias-ocular motility disorders
- Latent nystagmus
- Aniseikonia
- *Refractive errors*: Astigmatism; hyperopia; and anisometropia
- Accommodative paresis.

It thus becomes mandatory to recognize these conditions by exclusion and look for the accommodative reasons carefully.

Since, this article is dedicated to accommodative problems, let us briefly discuss the five syndromes which occur clinically:

1. *Insufficiency of accommodation:* It is a condition in which the amplitude of accommodation is chronically below the lower limits of expected amplitude of accommodation for the person's age. Classically, insufficiency of accommodation is a physiological phenomena of advancing age and very rare in children. But studies have shown that this problem is not too uncommon in children. In one study, children aged 10–15 years, with low accommodative amplitude, had severe complaints of asthenopia, headaches, diplopia, and difficulty in reading. Therefore, the clinical recognition of accommodative insufficiency is important in preventing unwanted frustration in school going children. The clinician should keep his mind open where such accommodative insufficiency is suspected, especially in circumstances of certain syndromes or the child is on drugs for psychological disorders.
2. *Infacility of accommodation:* As previously discussed, this is a condition in which a rapid change of accommodation from far to near and vice-versa is failing and raises symptoms of asthenopia. It differs from insufficiency in that clear vision is eventually achieved, albeit after some time. If changing fixation from distance to near takes >1 second, an abnormal condition is likely to be present. Children who need to change fixation rapidly from distance to near, as is commonly done in school in viewing blackboard and then writing at near, start complaining of ocular pain or headaches after long hours in school.
3. *Fatigue of accommodation:* Fatigue of accommodation is described as the inability of ciliary muscle to maintain contraction while viewing a near target with a resulting blurring of the object and shift of accommodation toward far point. Normally, in young children, the amplitude is so much in reserve that this condition is rare. If in a child, there is doubt of such a situation, then a thorough cycloplegic refraction is warranted to weed out hyperopia or astigmatism. Still, the reading habits and light source should also be enquired into.
4. *Spasm of accommodation:* Spasm of accommodation is a constant or intermittent involuntary and

inappropriate ciliary contraction. It may be unilateral or bilateral. Symptoms include distance and/or near blur, visual distortion, constant brow ache, or headaches, and sometimes diplopia. Also, a dynamic retinoscopy shows no change.

5. *Paresis of accommodation:* Paresis of accommodation could be partial or complete.

The most common cause of paresis is use of cycloplegic drops whether deliberate or inadvertent. It is to be understood that the use of cycloplegic drops used for refraction have a duration of effect; but it may not be surprising if the effect continues well beyond the stipulated time frame. In every case of suspected cycloplegic used, whether at your clinic or elsewhere, the type and date of refraction must be enquired.

Accommodative paresis can also be functional, owing to weakness, or fatigue of ciliary muscles.

Near work performance can also be hampered due to certain accommodative syndromes, neurological disorders, use of certain sedatives, anticholinergic drugs, antipsychotic drugs, hysteria, etc. The "accommodative facility" can be inherently deficient despite the amplitude being normal; thus, a thorough tests of various facets of accommodation should be done to arrive at a correct diagnosis of accommodative problem.

ACCOMMODATIVE THERAPY

Accommodative dysfunctions are not an uncommon visual anomaly in children and the symptoms typically occur during near work. Out of the dysfunctions mentioned above, accommodative "insufficiency" and accommodative "infacility" are the most common dysfunctions encountered in children. After ruling out neurological, pharmaceutical, and general health issues, the standard treatment of accommodative dysfunction is generally orthoptic exercises or addition of plus lens for near.

In cases of accommodative insufficiency, what is needed is a proper distance correction with an addition of appropriate plus lenses for near. Orthoptic exercises to strengthen vergence or accommodation by "push-up" technique should also be employed.

A plus lens add are recommended in cases of excessive "lag of accommodation", "very low PRA", or "fatigue of accommodation". The prescription can be either in form of normal reading glasses or bifocals.

Orthoptic exercise is a sequence of activities individually prescribed and monitored by the clinician to develop efficient visual skills and processing. "Flipper" method is one of the extremely efficient methods aimed at developing accommodative efficiency and "push-up" exercise to strengthen vergence and accommodation. Use of synoptophore is a time tested machine for orthoptic exercises, but the patients regular attendance are doubtful; even home-based exercises have proved to be equally effective and should be relied upon.

There is a scientific and clinical evidence to support the efficiency of using facility therapy techniques to strengthen or improve accommodative functions.

CONCLUSION

With all said and done, near work complaints and problems are on the increase in children, because of computers and mobile game gadgets, and as a vigilant clinician it is imperative that we take the near vision complaints of children seriously and make a conscience effort to look for accommodative anomalies. Asthenopic and related symptoms are a major problem in school-going children. With the inception of computers and other gadgets for near work, the unseen problems arising out of constant and continuous near work are on the rise. Parents wander from pillar to post, seeking respite from their child's constant complaints from near work; but inspite of best spectacle correction and avoidance of excessive near work, the complaints continue. Studies have shown that majority of these problems arise from defects in accommodation, even in a young child. Therefore, various aspects of accommodation deficiencies have to be studied clinically, detected, and treated to ameliorate the symptoms.

SUGGESTED READING

1. Atchison DA. Accommodation and presbyopia. Ophthalmic Physiol Opt. 1995;15(4):255-72.
2. Banks MS. The development of visual accommodation during early infancy. Child Dev. 1980;51(3):646-66.
3. Beers AP, van der Heijde GL. Age-related changes in the accommodation mechanism. Optom Vis Sci. 1996;73(4):235-42.
4. Bobier WR, Guinta A, Kurtz S, Howland HC. Prism induced accommodation in infants 3 to 6 months of age. Vision Res. 2000;40(5):529-37.
5. Bobier WR, Sivak JG. Orthoptic training of subjects showing slow accommodative responses. Am J Optom Physiol Opt. 1983;60(8):678-87.
6. Cacho P, Garcia A, Lara F, Seguí MM. Diagnostic signs of accommodative insufficiency. Optom Vis Sci. 2002;79(9):614-20.
7. Chiu NN, Rosenfield M. Tonic accommodation, tonic vergence, and surround propinquity. Ophthalmic Physiol Opt. 1994;14(3):290-2.
8. Chrousos GA, O'Neill JF, Lueth BD, Parks MM. Accommodation deficiency in healthy young individuals. J Pediatr Ophthalmol Strabismus. 1988;25(4):176-9.
9. Fisher RF. The mechanics of accommodation in relation to presbyopia. Eye. 1988;2:646-9.
10. Garcia A, Cacho P, Lara F, Megías R. The relation between accommodative facility and general binocular dysfunction. Ophthalmic Physiol Opt. 2000;20(2):98-104.
11. Goldstein JH, Schneekloth BB. Spasm of the near reflex: A spectrum of anomalies. Surv Ophthalmol. 1996;40(4):269-78.
12. Goss DA. Clinical accommodation testing. Curr Opin Ophthalmol. 1992;3(1):78-82.
13. Hung GK, Ciuffreda KJ. Sensitivity analysis of relative accommodative and vergence. IEEE Trans Biomed Eng. 1994;41(3):241-8.

14. Kedzia B, Pieczyrak D, Tondel G, Maples WC. Factors affecting the clinical testing of accommodative facility. Ophthalmic Physiol Opt. 1999;19(1):12-21.
15. Kruger PB, Aggarwala KR, Bean S, Mathews S. Accommodation to stationary and moving targets. Optom Vis Sci. 1997;74(7):505-10.
16. Leat SJ, Gargon JL. Accommodative response in children and young adults using dynamic retinoscopy. Ophthalmic Physiol Opt. 1996;16(5):375-84.
17. Marran LF, De Land PN, Nguyen AL. Accommodative insufficiency is the primary source of symptoms in children diagnosed with convergence insufficiency. Optom Vis Sci. 2006;83(5): 281-9.
18. Matsuo T, Ohtsuki H. Follow-up results of a combination of accommodation and convergence insufficiency in school-age children and adolescents. Graefes Arch Clin Exp Ophthalmol. 1992;230(2):166-70.
19. McLin LN Jr, Schor CM, Kruger PB. Changing size (looming) as a stimulus to accommodation and vergence. Vision Res. 1988;28(8):883-98.
20. Miwa T, Tokoro T. Dark focus of accommodation in children with accommodative esotropia and hyperopic anisometropia. Acta Ophthalmol (Copenh). 1993;71(6):819-24.
21. O'Leary CI, Evans BJW. Criteria for prescribing optometric interventions: literature review and practitioner survey. Ophthalmic Physiol Opt. 2003;23(5):429-39.
22. Owens DA, Wolf-Kelly K. Near work, visual fatigue, and variations of oculomotor tonus. Invest Ophthalmol Vis Sci. 1987;28(4): 743-9.
23. Pigion RG, Miller RJ. Fatigue of accommodation: changes in accommodation after visual work. Am J Optom Physiol Opt. 1985;62(12):853-63.
24. Rosenfield M, Cohen AS. Push-up amplitude of accommodation and target size. Ophthalmic Physiol Opt. 1995;15(3):231-2.
25. Russell GE, Wick B. A prospective study of treatment of accommodative insufficiency. Optom Vis Sci. 1993;70(2):131-5.
26. Scheiman M, Herzberg H, Frantz K, Margolies M. Normative study of accommodative facility in elementary school children. Am J Optom Physiol Opt. 1988;65(2):127-34.

Clinical Pediatric Ophthalmology and Strabismus

The extent to which visual anomalies hurt children–medically, psychologically, educationally, and socially–is unprecedented and is often underappreciated and overlooked. This book, therefore, encompasses myriad of ocular disorders and diseases which affect several parts of eye and the visual system. The book has emerged from long years of arduous, painstaking and sincere clinical work. It is also an essence of the plight, pains and pitfalls faced by children who suffer from ocular disorders. More importantly, the book is laced with chapters from experts from all over the world, who have penned the best and recent clinical advice, which will benefit the learner as well as the learned.

The book is divided into two parts—the first part deals with basic sciences of vision, their anomalies and diseases of eye and adnexa; while the second part is dedicated to strabismus.

The authors/editors humbly request to have this book on desk of every clinician who handles pediatric patients.

"The best and most beautiful things in life may not be seen or touched, but they can be felt in the heart."
—Hellen Keller (A nurse, who became blind at the age of 2 years, but inspired millions of blind persons)

"I am blind, but I have vision."
—Louise Braille (A visionary, who became blind at the age of 3 years, but invented the Braille alphabets, which is the educational tool for the blind)

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