



## Original Research Article

## Accommodative parameter assessment in peri-presbyopic early onset diabetics with age matched healthy individuals - A case control study

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## ABSTRACT

**Introduction:** To compare various accommodative parameters in peri-presbyopic diabetic patients with age-matched healthy individuals.

**Aim:** To compare Four Accommodative parameters in peri-presbyopic early onset diabetic patients and age matched non-diabetic individuals.

**Objectives:** 1. To compare and analyse Four accommodative parameters in peri-presbyopic early onset diabetics with that of peri-presbyopic age matched non-diabetic individuals (35-45; years); 2. To analyse the effect of treatment / metabolic control on the parameters. 3. To observe, if any, other systemic association that affects accommodation in both cases and controls.

**Materials and Methods:** Study setting – peri-presbyopic symptomatic patients attending the Ophthalmology outpatient department, from August 2016- December 2016. This cross-sectional case-control study was performed on 50 young onset peri-presbyopic early onset symptomatic diabetics and 50 age-matched peri-presbyopic, Non-diabetic individuals. Using the best correction for distance visual acuity, multiple accommodative ability tests such as near point of accommodation, accommodative amplitude, negative or positive accommodative facility and near point of convergence were measured in both groups.

**Results:** Statistical analysis made using SPSS version 16 Normality of distribution was checked with Kolmogrov-Smirnov test. Differences in accommodative functions between groups tested using student T test, Man Whitney test and repeated measures of analysis of variances. Level of significance was set at p-values <0.001. Mean NPA, Mean AA and Mean AF were statistically significant (p<0.001).

Mean positive RA, Mean negative RA and Mean NPC did not reach statistical significance.

**Conclusion:** Majority of accommodative ability functions are decreased in Peri-presbyopic diabetic patients. Early detection and rehabilitation of such patients with full near vision correction is strongly recommended.

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### 1. Introduction

Accommodation is the mechanism through which the shape of the crystalline lens is altered, thereby changing the refractive power of the eye.<sup>1</sup> During accommodation, contraction of ciliary muscles occur, allowing the relaxation of zonular fibres and increasing the convexity of crystalline lens, thereby moving the far point of the eye closer, to focus on near objects.<sup>1,2</sup>

In some systemic conditions such as Diabetes or debilitating disorders or physiological ageing process, the elasticity of the crystalline lens reduces thereby reducing the accommodative response.<sup>2</sup> Such patients in whom the accommodation is compromised, require supplementation of additional spectacle lens power to see near objects clearly. A couple of studies were performed on young diabetic patients to evaluate only accommodation amplitude and/or convergence. Early Treatment Diabetic Retinopathy Study group in 1995 compared Amplitude of Accommodation (AA) in white Pre-presbyopic diabetic and normal subjects,

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in which they used spherical lens power for Accommodation Amplitude (AA) measurement. It was found that AA was lower in diabetic patients & the mean AA for a 35-year-old diabetic patient was about four dioptres.<sup>3</sup> In the present study, we performed multiple accommodative ability tests in Peri-presbyopic diabetic patients to compare their accommodation characteristics with those of normal individuals.

## 2. Materials and Methods

This cross-sectional case-control study was performed in the Ophthalmology out-patient department, on peri-presbyopic symptomatic patients from August 2016-December 2016. The tests were conducted in 50 young peri-presbyopic patients diagnosed with symptomatic early-onset diabetes, henceforth to be referred to as cases, and 50 young healthy non-diabetic age matched individuals, who will henceforth be referred to as controls. Waiver of consent was obtained from the ethics committee as the study did not involve any extra procedure or cost for the participants. However oral consent was obtained for documenting the accommodative parameters. Patients with Snellens acuity of 6/9 - 6/6 were included in the study & were evaluated for Four accommodative tests viz. Near Point of Accommodation, Accommodative Amplitude, Accommodative Facility, Negative and Positive Relative Accommodation and Near Point of Convergence ; they were conducted in both groups.

### 2.1. Inclusion criteria for cases group were:

1. Individuals aged between 35 and 45 years (peri-presbyopic age group),
2. Diagnosed with diabetes mellitus by physician (according to ADA criteria),
3. History of taking oral hypoglycaemic drugs / Insulin / both
4. Best corrected VA 6/9 - 6/6 (undetected thus far)
5. No prior history / records of Ocular disease.
6. No previous records of diabetic retinopathy in fundus examination,
7. No other fundus pathology.
8. No known Ocular pathology.

Details such as the treatment taken (oral hypoglycaemic agents or insulin or both) for diabetes and the metabolic control (FBS, HbA1c, dyslipidemia) & the hypertension status were noted. The Glycaemic status and control were not taken as study criteria for exclusion, but it was noted whenever available for correlation.

Inclusion criteria for control group were healthy individuals in same age range without diabetes, BSCVA 6/9 - 6/6. Hypertension, Dyslipidaemia, if present among the control subjects, was noted. History of spectacle usage was specifically asked and whenever available, the details were

recorded. Auto-refractometer readings were recorded for all patients.

### 2.2. Exclusion criteria

1. Evidence of diabetic retinopathy (proliferative or non-proliferative in diabetes group),
2. Refractive error with BCVA < 6/9.
3. Previous ocular surgery.

Demographic data including age, gender, type of diabetes (insulin-dependent or non-insulin-dependent) and duration of disease were recorded.

Detailed ocular examination including best corrected visual acuity, alternate cover test for detection of any phorias or tropias, slit lamp biomicroscopy were done. Intra ocular pressure & fundus examination were done along with other relevant clinical tests for all patients as per the routine protocol. Near vision was recorded using the Jaeger's chart at 33cm, in ambient illumination.

All tests were run binocularly and instruction set was similar for both cases and controls.

The following tests for Accommodation were done:

### 2.3. Near Point of Accommodation (NPA)

It was measured by the push-up method. The participant wore his/her best distance correction, and a 6/6-6/9 size target on the ruler was moved slowly toward the nose until the observer reported the first blur. The distance from ruler was read and expressed in centimetre. Accommodative Amplitude is defined as the reciprocal of Near Point of Accommodation and expressed in dioptres.

### 2.4. Accommodation Facility (AF)

This is the fatigue induced while testing for accommodative ability of the individual. Full correction was given for distance and in good illumination, accommodative target of 6/6-6/9 sizes was viewed at near distance of 40 cm by each eye separately. Lens pairs mounted in a double-sided lens holder were repeatedly introduced over each eye and the time needed to see the target clearly was measured. The duration of testing was one minute and expressed as Cycle (times to see the target clearly) Per Minute (CPM). This test could reveal one of these problems Accommodative insufficiency, accommodative excess or ill sustained accommodation.<sup>4</sup>

### 2.5. Relative Accommodation (RA)

With appropriate refractive correction for distance in place, accommodative target was viewed. Minus or plus sphere with 0.25D interval in power were incrementally replaced until the observer reported consistent blurring of the target. The strongest power which caused blurring was recorded and expressed as dioptre (negative value for positive relative

accommodation & positive value for negative relative accommodation).

Relative accommodation: measure of maximum ability to stimulate accommodation while maintaining clear BSV. Negative Relative Accommodation (NRA): add +0.25D increments, until patient reports first sustained blur. Total value of lenses added to reach this point is NRA value. High NRA values (> +2.5D) might be evidence to uncorrected hyperopia or latent hyperopia. Positive Relative Accommodation (PRA): examiner adds lenses in -0.25D increments until patient reports first blur. Total value of lenses added to reach it is PRA.

High PRA (> -3.5D) is diagnostic of disorders of accommodative excess. Accommodative insufficiency is seen with PRA values < -1.50D.

### 2.6. Near Point of Convergence (NPC)

This was measured using the ruler and push-up method. In this technique (6/6-6/9) target size on ruler was moved towards the observer. Nearest point when the patient lost his/her fixation or developed diplopia was defined as the near point of convergence and expressed in centimetres.

### 3. Results

Statistical analysis made using SPSS version 16, Normality of distribution was checked with Kolmogorov-Smirnov test. Differences in accommodative functions between groups tested using student t test, Man Whitney test and repeated measures analysis of variances. Level of significance was set at p-values <0.001. Case and control groups included 50 individuals each. The percentage of Males and females in the case and control group were 66%, 34% and 72%, 28% respectively. Mean age in the case group was 40.26±0.92 and that in the control group was 39.92±1.24 years respectively. Mean NPA was (16.06 ± 1.73) cm in the cases and (9.5 ± 1.43) cm in normal individuals; this difference was significantly different (p<0.001). The difference of mean AA was statistically significant between groups (6.25 ± 0.65)D in the case and (10.69 ± 1.62)D in the control group (p<0.001).

Mean AF was (5.12 ± 0.79) CPM in the case and (10.68 ± 1.49) CPM in the control group; the difference of which was statistically insignificant (p <0.001). Mean positive RA was (-2.50 ± 0.40) D in the case and (-2.52 ± 0.32) D in the control group which did not have a significant difference. Mean negative RA was (1.56 ± 0.21) D in the case and (1.6 ± 0.22) D in control group which had no significant difference (p= 0.18). Mean NPC was (7.34 ± 0.45) cm in the case and (7.4 ± 0.49) cm in the control group; however, this different did not reach statistical significance (p=0.26).

As seen in Table 1, maximum number of patients suffering from diabetes were found in the 5-7 years range followed by 8-10 years range.

**Table 1:** Duration of diabetes

Number of Years	Patients
2-4	10
5-7	24
8-10	15
>10	1

**Table 2:** Age – wise distribution

Age (years)	Cases	Controls
35-37	10	14
38-40	16	15
41-43	15	13
44-45	9	8

Table 2 shows the distribution of subjects in the cases and controls group. Maximum number of patients were seen in 38-40 years range closely followed by 41-43 years range. In the controls, there was an almost equal distribution in all 3 age ranges except 44-45 years having only 8 patients.

### 4. Discussion

The premature loss of accommodative amplitude is called Accommodation insufficiency.<sup>1</sup> It manifests as blurring of the near vision or when there is an inability to sustain the accommodative effort. The onset may be a presage to the development of asthenopic symptoms, which causes blurred near vision. Early onset presbyopia may indicate concurrent or past debilitating disorder such as diabetes mellitus or it may be induced by medication such as sedatives or anticholinergic drugs used in treating certain gastrointestinal disorders. In these cases, the condition may be reversible. Perpetual accommodative insufficiency can be associated with some neurological disorders like encephalitis or head trauma. Such patients require additional reading aid for near visual activity.<sup>1,2</sup>

Diabetes mellitus is a major cause of blindness in 20-74 years age individuals in the United States.<sup>4</sup> India houses nearly 69.1 million people with DM and is estimated to have the second highest number of cases of DM in the world.<sup>5</sup> In India, the prevalence of Diabetes Mellitus ranges from 5-17%, with higher levels found predominantly in the southern part of the country and in urban areas.<sup>6</sup>

One of the commonly neglected problems in these patients is Accommodative insufficiency, which, if left untreated leads to deterioration in their quality of life. A couple of previous studies have investigated the accommodation changes in young diabetic patients. Duane conducted a study in 1925 which measured NPC and AA in healthy individuals, which has been benchmarked as a reference for further studies till date.<sup>7</sup> Another study conducted by Pawelski and Glien in 1971, compared the accommodative amplitude between white American diabetic and healthy subjects in young age and measured

**Table 3:** Vision-distance

	6/6		6/6p		6/9	
	Cases	Controls	Cases	Controls	Cases	Controls
35-37	6	9	2	2	2	3
38-40	8	9	5	4	3	2
41-43	9	7	3	5	3	1
44-45	5	5	3	2	1	1

**Table 4:** Duration of DM - Age wise distribution

	35-37	38-40	41-43	44-45
2-4	3	5	1	1
5-7	6	10	6	2
8-10	1	2	7	5
>10	0	0	0	1

**Table 5:** Near point of accommodation

NPA (cm)	Cases	Controls
8-10	0	37
11-13	0	13
14-16	31	0
17-19	19	0

**Table 6:** Duration of DM & NPA

	14	15	16	17	18	19	20
2-4	5	1	2	-	21	-	-
5-7	7	6	3	6	2	-	-
8-10	1	2	3	1	5	2	1
>10	-	-	-	-	-	1	-

**Table 7:** Accommodative ability

	Cases	Controls
5-7	49	0
8-10	1	26
11-13	0	24

**Table 8:** Accommodative facility

	Cases	Controls
4-6	50	0
7-9	0	12
10-12	0	34
13-15	0	4

**Table 9:** Relative accommodation: IXA Positive RA

	Cases	Controls
-1.50- -1.75	3	0
-2.0- -2.25	11	10
-2.50- -2.75	22	30
-3.0- -3.25	14	10
<b>IXB Negative RA:</b>		
+1- +1.25	4	1
+1.50- +1.75	40	39
+2.0- +2.25	6	10

**Table 10:** Near point of convergence

	Cases	Controls
7	31	30
7.5	4	0
8	15	20

**Table 11:** Duration of DM & AA

	5	5.5	6	6.5	7
2-4	-	2	-	3	5
5-7	-	2	8	6	8
8-10	1	7	1	5	1
> 10	-	1	-	-	-

**Table 12:** Duration of DM & AF

	4	5	6
2-4	1	2	7
5-7	3	11	10
8-10	8	5	2
>10	1	-	-

**Table 13:** Duration of DM & RA 14A – Duration of DM with PRA

	-1.50 to -1.75	-2.0 to -2.25	-2.50 to -2.75	-3.0 to -3.25
2-4	-	2	5	3
5-7	1	8	9	6
8-10	1	1	8	5
7-10	1	-	-	-

**Table 14:** Duration of DM with NRA

	+1 to +1.25	+1.50 to 1.75	+2 to +2.25
2-4	-	9	1
5-7	2	19	3
8-10	2	10	3
>10	-	1	-

**Table 15:** Duration of DM & NPC

	7	7.5	8
2-4	7	-	3
5-7	20	1	3
8-10	4	3	8
>10	-	-	1

**Table 16:** RBS status age wise distribution (cases)

	131-150	151-170	171-190
35-37	1	8	-
38-40	-	19	1
41-43	1	9	2
44-45	-	6	3

**Table 17:** Age wise distribution & RBS (controls)

	71-80	81-90
35-37	9	6
38-40	3	11
41-43	4	9
44-45	1	7

**Table 18:** RBS – Age wise distribution

	Cases 130-190	Controls 70-90
35-37	9	15
38-40	20	14
41-43	12	13
44-45	9	8

**Table 19:** Controls

	NPA		NPC		AA		AF		PRA		NRA	
	H	L	H	L	H	L	H	L	H	L	H	L
35-37	8	10	7	8	12.5	10	13	11	-2.25	-3.0	+1.50	+2.0
38-40	8	10	7	8	11	10	12	9	-1.50	-3.0	+1.0	+2.25
41-43	9	11	7	8	10	8	10	8	-1.75	-3.0	+1.0	+2.50
44-45	11	12	8	8	9	8	10	8	-1.5	-1.75	+1.50	+2.0

**Table 20:** Cases

	NPA		NPC		AA		AF		PRA		NRA	
	H	L	H	L	H	L	H	L	H	L	H	L
35-37	14	18	7	8	5.5	7	4	6	-2	-3	+1.50	+2.0
38-40	14	18	7	8	5.5	7	4	6	-1.5	-3	+1.0	+2.25
41-43	14	20	7	8	5	7	4	6	-1.5	-3.25	+1.0	+2.25
44-45	-	19	7	8	5.5		4		-1.5		+1.50	

**Table 21:** Measured accommodation parameters in population study

Mean	Diabetic	Control	p value
NPA(cm)	16.06 ± 1.73	9.5 ± 1.43	< 0.001
AA(D)	6.25 ± 0.65	10.69 ± 1.62	< 0.001
AF (cycle/minute)	5.12 ± 0.79	10.68 ± 1.49	< 0.001
Positive relative accommodation (D)	-2.50 ± 0.40	-2.52 ± 0.32	0.39
Negative relative accommodation (D)	1.56 ± 0.21	1.6 ± 0.22	0.18
NPC (cm)	7.34 ± 0.45	7.4 ± 0.49	0.26

Accommodative Amplitude by the push up technique, the result of which was a decreased AA in diabetic group.<sup>8</sup> A study by Moss in 1988 on 61 subjects ages ranged 9-16 years in two groups (diabetic versus normal) showed lower AA in diabetic patients (9.9 versus 11.8 D).<sup>9</sup>

Till date there has been no study which describes the effects of diabetes on accommodation in young peripresbyopic age group. In our study, we aim to highlight the effects of diabetes on young Indians.

The NPA and NPC measurements are more or less similar in terms of the technique. While the NPC remains relatively unaffected, only the NPA seems to deteriorate in diabetics. This observation is logical as it seems like the diabetic subjects should have seen the targets blurred for closer distance (distances closer than the NPA) in the NPC measurements.<sup>10</sup> This has been observed in our study as well.

Similar to other studies, we found that most accommodation ability tests including AA were lower

in diabetic patients. One advantage of our study was quantification of multiple parameters of accommodation in normal & young onset peri-presbyopic diabetic individuals.

Accommodative performance can probably be correlated with biochemical parameters measured in the experiment (i.e. HbA1c levels, FBS, PPBS). These parameters were recorded to observe for a possible co-relation, as it might provide more insights into pathogenesis of deteriorating accommodative performance in diabetic patients. We found that similar measurements were obtained in all treatment groups, i.e., those on oral hypoglycaemic agents/ insulin/ both. Some of the cases were also hypertensive, but there was no significant correlation. History of use of any oral contraceptives was elicited in female subjects, to look for any correlation, as these agents are known to have an effect on the crystalline lens, which further affects the accommodation and thence leads to changes in vision.<sup>11</sup> But due to the small sample size and the lack of proper reliable information we were not able to assess this.

Disadvantage: A considerable problem of the tests employed is their subjective component since one has to rely on patient's perception.

## 5. Conclusion

Defective accommodation may have an early onset in young diabetic patients. Early diagnosis and appropriate rehabilitation with proper corrective lenses may improve symptoms and probably improve quality of life in these patients. Further research with a large sample size is required in this field to include more factors such as co-existent hypertension or contraceptives used by females to examine/explore what effects they may have on accommodation.

## 6. Source of Funding

None.

## 7. Conflict of Interest

None.

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