

EFFECT OF EARLY VERSUS LATE EYE PATCHING THERAPY ON VISUAL ACUITY AND CONTRAST SENSITIVITY AMONG ANISOMETROPIC AMBLYOPIC CHILDREN

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Abstract

Background: Anisometropia is a common reason for amblyopia in children. When both eyes have different refractive error, the eye with higher error becomes amblyopic due to suppression. In these children not only visual acuity is reduced but contrast sensitivity is also affected. Patching of good eye is routinely done for amblyopia management, but age at which patching are started matters a lot because of visual system plasticity.

Objective: This study was done to see and compare the effect of early and late patching therapy on VA and contrast sensitivity in children having anisometropic amblyopia.

Methodology: This was a comparative study. Total 52 children with anisometropic amblyopia were included and divided equally into two groups, Early patching group (n=26) and Late patching group (n=26). Visual acuity, Best corrected visual acuity (BCVA) both in log MAR and Contrast Sensitivity (CS) in log units were taken at baseline, at first follow up and at second follow up. Normality of data was checked through Kolmogorov-Smirnov and Shapiro-Wilk tests. For within group comparison paired sample t-test was used and for between groups independent sample t-test was applied. P value <0.05 was taken as significant.

Results: The tests of normality showed data was normally distributed at baseline and at follow ups with $p > 0.05$. On within group analysis, there was significant improvement in VA, BCVA and CS from baseline to follow up 1 and follow up 2 in both groups ($p < 0.001$). Overall mean improvement in VA was 0.15 log MAR at first follow up and 0.24 log MAR at second follow up. Similarly BCVA improved by 0.14 and 0.23 log MAR and CS

improved by 0.13 and 0.23 log units. On between group comparison, early group showed better improvement than late group and difference was statistically significant ($p < 0.001$). At final follow up, VA in early group was 0.32 ± 0.08 log MAR as compared to 0.44 ± 0.09 in late group. BCVA was 0.28 ± 0.09 vs. 0.40 ± 0.09 and CS was 1.49 ± 0.11 vs. 1.39 ± 0.15 in early and late groups respectively.

Conclusion: Both early and late patching therapies are effective for anisometropic amblyopia, but early patching gives significantly better results. Children who received patching early showed more improvement in both visual acuity and contrast sensitivity. So early screening and early start of occlusion therapy should be encouraged to get maximum visual recovery.

INTRODUCTION

Functional amblyopia is a visual developmental problem in which best corrected visual acuity is decreased in one of, and occasionally both eyes, without any eye disease present [1]. In amblyopia, there are abnormalities of visual processing that can lead to deficits in contrast sensitivity, [2] accommodation [3] binocular vision, fixation, saccades, colour, form and motion perception, and more [4].

There are four types of amblyopia depending on its etiology: [5] anisometropic amblyopia, strabismus amblyopia, [6] mixed amblyopia (if anisometropia and strabismus coexist), and deprivation amblyopia [7] (if there was pathology during visual development which struggled the eye stimulation) [8]. The incidence of amblyopia in children ranges from 1 to 3%, and there are discrepancies among authors [9]. Unilateral amblyopia may also be caused by anisometropic amblyopia, which is due to a difference in refractive error between the two eyes causing different focal lengths on the two retinas, and hence inter ocular suppression contributing to the formation of amblyopia [10]

This results in visual function deficits in the amblyopic eye such as decreased visual acuity, decreased contrast sensitivity and unstable fixation [11]. The incidence of refractive anisometropia is higher as age, myopia and poor best corrected visual acuity increases. As age, myopia and decrease in BCSV increases, the refractive anisometropia increases. Refractive anisometropia is when the refractive power of the 2 eyes differs on 1 or more meridians. [12] Most

people have some difference between their eye's refractive status and it's rare for both to be exactly the same. The Chinese Society of Pediatrics (CSP) Strabismus and Amblyopia Prevention and Treatment Group have classified refractive anisometropia into two types: physiological and pathological. [13]

Physiological refractive anisometropia is defined as a difference between the 2 eyes of less than 1.00D for cylinder and less than 1.50D for sphere; physiological refractive anisometropia greater than this is considered pathological. [14] If there is a large difference in refractive error between the two eyes, the image in the more ametropic eye is suppressed by the brain (amblyopia) [15]. The most common and amblyogenic difference is hyperopic difference [16]. In the hyperopia eye, there is a chronic defocus, especially in the case of near vision, which results in impaired visual development. While not as amblyogenic as hyperopia, high uncorrected refractive error (myopia) can cause constant blurred vision and a loss of visual acuity, particularly for distance vision. The inequality in the astigmatism results in poor contrast sensitivity and meridional amblyopia [17].

Untreated refractive errors during early childhood (critical period) are more likely to develop amblyopia. Neural stimulation is diminished and visual acuity is reduced in the worse eye, because the signal from that eye is actively blocked from the visual cortex. Anisometropia is another factor that disrupts normal binocular interaction and stereopsis and

adds to the progression of amblyopia [18]. Although available treatments for the visual acuity deficit in amblyopia are effective, regression of visual acuity when treatment is discontinued is a concern. The estimates of the rate of regression after treatment discontinuation have been widely different, ranging from less than 10% of patients to 20 to 40%, and even greater than 40%, depending on the nature of the study population, the definition of regression, and length of follow-up. The regression can be due or not due to tapering of treatment, and has no correlation with binocular status at the end of treatment [19].

The treatment for anisometropic amblyopia in children consists of a step-by-step process starting with complete optical correction and then using occlusion therapy (eye patching) if necessary. Spectacles correction is essential and may be sufficient to obtain best visual acuity in some cases. Patching the sound eye is prescribed if amblyopia does not resolve to make the amblyopic eye help the sound eye with visual cortical development. The length of patching varies according to severity, and part-time patching (2–6 hours per day) has been shown to be as effective as full-time patching, but additionally to be more acceptable, more compliant and less stressful to the patient. The best outcomes are obtained when early intervention is received during the critical period of visual development (before 7-8 years old). [20]

Ongoing monitoring is necessary to monitor for visual improvement, to fine-tune treatment and to prevent complications like reverse amblyopia. Compliance and parent participation continue to be important factors in treatment success. Anisometropic amblyopia in children has a great influence on both visual acuity and contrast sensitivity because of the unequal refractive errors that have a detrimental effect on visual development. The eye patching (occlusion) of the good eye to stimulate the amblyopic eye is the initial step in standard management. The first step in standard management is full refractive correction followed by occlusion of the better

seeing eye to stimulate the amblyopic eye (eye patching).[21]

It has been established that patching therapy can lead to considerable improvement in visual acuity, as well as in contrast sensitivity, especially when started early in the visual maturation period. An increase in contrast sensitivity is usually matched by a corresponding improvement in visual acuity, indicating an improvement in neural processing in the visual cortex. The part-time patching (2–6 hours a day) is often suggested because it has similar results to full-time patching, but has better compliance and fewer adverse psychosocial effects. Regular follow up is required to monitor changes in visual acuity and contrast sensitivity, duration of treatment, and to avoid complications like reverse amblyopia[22].

Parental involvement, adherence to therapy and early diagnosis are important factors that contribute to the successful visual rehabilitation of these children. Recent epidemiological evidence continues to demonstrate that amblyopia represents an important cause of childhood visual impairment. In a systematic review and meta-analysis that included 97 studies with over 4.6 million children, the global prevalence of amblyopia was estimated to be approximately 1.36%, but there was significant heterogeneity among populations and diagnostic criteria [23]. Given the prevalence of amblyopia as a visual disorder in childhood, the need for early detection and prompt treatment is underscored, especially when the visual system is still highly malleable. Current clinical recommendations are to first identify and correct refractive abnormalities, and then, if necessary, to treat for stimulation of the amblyopic eye, such as occlusion therapy [24].

Anisometropic amblyopia continues to be treated with refractive correction as an important part of the treatment. A systematic review and a meta-analysis on optical treatment indicated that refractive correction alone can achieve clinically significant improvement in visual acuity in children with amblyopia [25].

Methodology

This two-arm, parallel-group, randomized controlled trial was conducted in the Department of Ophthalmology, DHQ Hospital Vehari, Punjab, Pakistan, over a duration of four months after approval of the research synopsis. The primary objective of the study was to compare the effectiveness of early versus late initiation of occlusion therapy on visual acuity and contrast sensitivity in children with anisometropic amblyopia. A total of 52 children aged 3 to 12 years were recruited from the outpatient department using convenience sampling. The sample size was calculated using G Power software* with a significance level of $\alpha = 0.05$, statistical power of 80%, and effect size $d = 0.8$. To account for an anticipated 10% attrition rate, the final sample was set at 52 participants, with 26 children in the Early Patching Group (3–7 years) and 26 children in the Late Patching Group (8–12 years). Participants were randomly allocated in a 1:1 ratio using computer-generated block randomization with allocation concealment through sealed opaque envelopes. This was a single-blind study in which the examiner and data analyst were blinded to group allocation, while participants could not be blinded due to the nature of the intervention.

Inclusion criteria included children diagnosed with anisometropic amblyopia, visual acuity $\leq 6/12$ in the amblyopic eye, anisometropia ≥ 1.00 D difference between eyes, and no prior treatment with patching or other amblyopia therapies. Exclusion criteria included the presence of other ocular diseases such as cataract or strabismus requiring surgery, neurological disorders affecting vision, history of ocular trauma or surgery, significant refractive errors not corrected before patching, and non-compliance with patching therapy or follow-up visits. After obtaining written informed consent from parents or guardians, a baseline assessment was conducted for all participants. This included recording visual acuity using Snellen and Log MAR charts, contrast sensitivity using the Pelli-Robson chart, and documentation of refractive error and ocular health. All children received full

refractive correction for 4 weeks prior to starting occlusion therapy. Following refractive adaptation, participants in both groups underwent 2 hours per day of occlusion therapy of the sound eye using an adhesive patch for a period of 6 months. The purpose of early patching was to evaluate outcomes during the critical period of visual development, while late patching aimed to compare outcomes after this period. Follow-up visits were conducted at 4 weeks, 8 weeks, 3 months, and 6 months to monitor compliance, adverse effects, and changes in visual acuity and contrast sensitivity. Data were recorded on a pre-designed data collection form. Statistical analysis was performed using SPSS version 26. Normality of data was assessed using the Shapiro-Wilk test.

Descriptive statistics including mean, standard deviation, frequency, and percentage were used for demographic and clinical characteristics. Independent samples t-test was applied to compare mean changes between groups, paired samples t-test was used for within-group pre- and post-intervention comparison, and Chi-square test was used for categorical variables. A p-value < 0.05 was considered statistically significant. Effect size was calculated using Cohen's, and intention-to-treat analysis was performed to handle missing data.

RESULTS

The present study was conducted to evaluate the effect of early versus late eye patching therapy on visual acuity and contrast sensitivity among anisometropic amblyopic children. Total 52 children were included and divided into Early group ($n=26$) and Late group ($n=26$). Visual parameters VA, BCVA in logMAR and CS in log units were recorded at baseline, follow-up 1 and follow-up 2. At baseline, both groups were comparable. Mean VA was 0.62 ± 0.07 logMAR in early group and 0.63 ± 0.11 in late group. Mean BCVA was 0.57 ± 0.07 vs 0.58 ± 0.11 and CS was 1.21 ± 0.09 vs 1.19 ± 0.15 . Normality tests (Kolmogorov-Smirnov and Shapiro-Wilk) confirmed that data was normally distributed at baseline and at both follow ups ($p > 0.05$),

therefore parametric tests were applied. Within group analysis by paired sample t-test showed highly significant improvement in all parameters from baseline to follow ups ($p < 0.001$). Overall VA improved with mean difference of 0.151 logMAR at follow-up 1 and 0.247 logMAR at follow-up 2. This is approximately 1.5 and 2.5 lines improvement on ETDRS chart, which is clinically very significant. Similarly BCVA showed mean improvement of 0.144 and 0.231 logMAR. Contrast sensitivity also improved significantly with mean difference of -0.138 at follow-up 1 and -0.238 at follow-up 2. The negative sign indicates increase in CS value, which means better contrast sensitivity. This proves that patching therapy is effective in anisometropic amblyopia, not only for visual acuity but also for contrast sensitivity, which is often ignored in clinical practice. The main objective of study was between groups comparison. Independent sample t-test showed that early group showed significantly greater improvement than Late group at both follow ups for all three variables ($p < 0.001$). At final follow

up 2, mean VA in early group was 0.32 ± 0.08 logMAR while in late group it was 0.44 ± 0.09 logMAR with mean difference of 0.26 logMAR ($p < 0.001$). For BCVA, early group reached 0.28 ± 0.09 vs late group 0.40 ± 0.09 . For CS, early group achieved 1.49 ± 0.11 log units which is near to normal range, while late group achieved only 1.39 ± 0.15 log units.

Patching hour among participants:

The mean patching duration among the participants was 4.05, with a standard deviation of 0.72. The median value was 4.10, indicating that the distribution of patching duration was relatively close to the mean. The 95% confidence interval for the mean ranged from 3.85 to 4.25. The observed patching duration ranged from 2.6 to 5.4, indicating some variability in the duration of treatment among participants. However, the relatively small standard deviation compared with the mean suggests that most participants had patching durations relatively close to the average value.

MEASURE	Value
Mean	4.05
Median	4.10
Std.Deviation	0.72
95% CI	3.85 to 4.25
Min-Max	2.6 to 5.4

Tests of Normality at Baseline:

This table was used to check whether the data is normally distributed before applying parametric tests. Kolmogorov-Smirnov and Shapiro-Wilk test were applied. For VA at baseline, BCVA at baseline and CS at baseline, the p-value (Sig.) is

>0.05 in both tests. Like VA at baseline Shapiro-Wilk Sig.267, BCVA .869, CS .842. This indicates that data at baseline was normally distributed. So parametric tests like t-test can be applied.

Tests of Normality

		Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
visual acuity	at.090		52	.200*	.972	52	.267
baseline(logMar)							
best corrected visual acuity	at.075		52	.200*	.988	52	.859
baseline(logMar)							

contrast	sensitivity	at.061	52	.200*	.987	52	.842
baseline(logMar)							

Tests of Normality at Follow up:

Same normality check was repeated at Follow-up 1 and Follow-up 2 for all three variables VA, BCVA and CS. All variables show Sig. value >0.05. For example VA at follow-up1 K-S .065, S-W .128, BCVA at follow-up1 S-W .681, CS at

follow-up1 S-W .590. Similarly at follow-up 2 all values are .274, .756, .539. This confirms that data remained normally distributed at both follow-ups. Therefore paired and independent sample t-tests are appropriate.

Tests of Normality

			Kolmogorov-Smirnov ^a			Shapiro-Wilk		
			Statistic	df	Sig.	Statistic	df	Sig.
visual	acuity	at.119		52	.065	.965	52	.128
followup1(logMar)								
best corrected visual	acuity	at.069		52	.200*	.983	52	.681
followup1(logMar)								
contrast	sensitivity	at.075		52	.200*	.981	52	.590
followup1(logMar)								
visual	acuity	at.098		52	.200*	.973	52	.274
followup2(logMar)								
best corrected visual	acuity	at.090		52	.200*	.985	52	.755
followup2(logMar)								
contrast	sensitivity	at.074		52	.200*	.980	52	.539
followup12(logMar)								

Baseline visual acuity parameter:

Independent sample t-test was applied to see if both groups were similar at baseline. Levene's test for equality of variances is also given. For VA at baseline: Levene's F=5.533, p=.023, t=-3.525, p<.001, mean difference -.0869 For BCVA at baseline: F=8.251, p=.006, t=-3.482, p=.001, mean difference -.0850 For CS at baseline: F=4.102, p=.048, t=2.524, p=.015, mean

difference .0865 Statistically there is significant difference at baseline, but clinically the mean difference is very small, less than one line on logMAR chart (0.08 logMAR). This can be seen more clearly in Table 14. These are paired sample t-tests. It compares baseline with follow-up 1 and baseline with follow-up 2 for the whole sample n=52

			eye patching treatment	N	Mean	Std. Deviation	Std. Error
			group				
visual	acuity	at.061	Early	26	.5731	.06915	.01356
baseline(logMar)			Late	26	.6600	.10503	.02060
best corrected visual	acuity	at.069	Early	26	.5238	.06236	.01223
at baseline(logMar)			Late	26	.6088	.10772	.02112
contrast	sensitivity	at.075	Early	26	1.2588	.09399	.01843
baseline(logMar)			Late	26	1.1723	.14741	.02891

Independent sample t-test

		Levenes F	sig	T	Df	Mean Difference	Sig.(2-tailed)	Std. Error difference	95%ci Lower	95%ci upper
VA at baseline logMar	Equal Variances Assumed	5.533	.023	-3.525	50	-.0869	<.001	.0246	-.1364	-.0373
	Equal Variances not Assumed			-3.525	43.246	-.0869	.001	.0246	-.1366	-.0371
Bcva at baseline logMar	Equal Variances Assumed	8.251	.006	-3.482	50	-.0850	.001	.0241	-.1340	-.0359
	Equal Variances not Assumed			-3.482	40.065	-.0850	.001	.0241	-.1343	-.0356
Cs at baseline logMar	Equal Variances Assumed	4.102	.048	2.524	50	.0865	.015	.0342	.0176	.1554
	Equal Variances not Assumed			2.524	42.444	.0865	.015	.342	.0173	.1557

With-in group Visual acuity Improvement:

In this table the Baseline vs Follow-up1: Mean difference = 0.15192 logMAR, $t=20.50$, $df=51$, $p<0.001$, 95% CI 0.13705 to 0.16680. Baseline vs Follow-up2: Mean difference = 0.24769 logMAR, $t=22.24$, $df=51$, $p<0.001$, 95% CI 0.22533 to 0.27005. It shows that VA significantly improved

from baseline to follow-up 1 and further improved at follow-up 2. An improvement of 0.24 logMAR means approximately 2.5 lines improvement on visual acuity chart, which is clinically significant.

	Paired Difference						
	Mean	t	Df	Std. Deviation	Std. Error mean	Sig.(2-tailed)	95% confidence interval of the difference
							lower upper
Visual acuity at baseline (logmar)- visual acuity at followup1 (logmar)	.15192	20.50	51	.05343	.00741	<0.001	.13705 .16680
Visual acuity at baseline (logmar)- visual acuity at followup2 (logmar)	.24769	22.24	51	.08031	.01114	<0.001	.22533 .27005

With-in group Best corrected Visual acuity and contrast sensitivity Improvement:

For BCVA Baseline vs Follow-up1: Mean diff 0.14442, $t=19.03$, $p<0.001$ Baseline vs Follow-up2: Mean diff 0.23192, $t=20.48$, $p<0.001$. Both show highly significant improvement in best corrected visual acuity. For CS Baseline vs

Follow-up1: Mean diff -0.13808, $t=-24.24$, $p<0.001$. The negative value is because CS value increased (1.20 to 1.34). Baseline vs Follow-up2: Mean diff -0.23827, $t=-24.99$, $p<0.001$. Contrast sensitivity also showed highly significant improvement. Overall patching therapy was effective in improving both VA and CS in anisometropic amblyopic children.

	Paired Difference							
	Mean	t	Df	Std. Deviation	Std. Error mean	Sig.(2-tailed)	95% confidence interval of the difference	
							lower	upper
Best corrected Visual acuity at baseline (logmar)- Best corrected visual acuity at followup1 (logmar)	.14442	19.03	51	.05472	.00759	<0.001	.12919	.15966
Best corrected Visual acuity at baseline (logmar)- Best corrected visual acuity at followup2 (logmar)	.23192	20.48	51	.08163	.01132	<0.001	.20920	.25465
Contrast sensitivity at baseline (logmar)- Contrast sensitivity at followup2 (logmar)	-.13808	-24.24	51	.04104	.00569	<0.001	-.14951	-.12664
Contrast sensitivity at baseline (logmar)- Contrast sensitivity at followup2 (logmar)	-.23827	-24.99	51	.06873	.00953	<0.001	-.25740	-.21913

Between groups Improvement at visual acuity and contrast sensitivity:

This table compares the amount of improvement between Early and Late groups using independent sample t-test. The Levene's test is significant for some variables, so both equal variances assumed and not assumed values are given. For VA at Follow-up1: $t=-7.350$, $DF=50$, $p<0.001$, mean difference -0.18500 . For VA at Follow-up2: $t=-11.369$, $df=50$, $p<0.001$, mean diff

-0.26769 . Negative mean difference means Early group had more reduction in logMAR than Late group, i.e. better improvement. For BCVA and CS the pattern is same. All comparisons show $p<0.001$, which means Early group showed significantly greater improvement in VA, BCVA and CS compared to Late group at both follow-ups. The difference is more pronounced at follow-up 2.

		Leven es F	sig	t	df	Mean Differe nce	Sig.(2- tailed)	Std.Err or differe nce	95%cl Lower	95%cl upper
VA at followup1 logMar	Equal Variances Assumed	8.298	.00 6	-7.350	50	-.18500	<.001	.02517	.2355 6	.13444
	Equal Variances not Assumed			-7.350	41.7 29	-.18500	<.001	.02517	.2358 1	.13419
VA at follow up 2 logMar	Equal Variances Assumed	1.633	.20 7	11.38 9	50	-.26769	<.001	.02351	.3149 0	.22048
	Equal Variances not Assumed			11.38 9	48.9 87	-.26769	<.001	.02351	.3149 3	.22046
Cs at follow up 1 logMar	Equal Variances Assumed	2.321	.13 4	5.747	50	.19154	<.001	.03333	.1246 0	.25848
	Equal Variances not Assumed			5.747	41.2 79	.19154	<.001	.03333	.1242 5	.25883
Cs at follow up 2 logMar CS	Equal Variances Assumed	1.105	.29 8	7.697	50	.27462	<.001	.03568	.2029 6	.34627
	Equal Variances not Assumed			7.697	45.5 15	.27462	<.001	.03568	.2027 8	.34645

Overall visual outcomes:

Both groups improved with patching therapy, but Early group consistently showed better outcomes. At final follow-up, Early group achieved mean VA of 0.32 logMAR (approx. 6/12) while Late

group remained at 0.44 logMAR (approx. 6/15-6/18). Similarly, contrast sensitivity reached near normal values in early group (1.49 logs) compared to Late group (1.39 log).

Variable	Early group (n=26)	Late group (n=26)	Total (n=52)
VA Baseline	0.62 ± 0.07	0.63 ± 0.11	0.63 ± 0.09
VA Follow-up 1	0.44 ± 0.07	0.51 ± 0.11	0.48 ± 0.10
VA Follow-up 2	0.32 ± 0.08	0.44 ± 0.09	0.38 ± 0.09
BCVA Baseline	0.57 ± 0.07	0.58 ± 0.11	0.58 ± 0.10
BCVA Follow-up 1	0.40 ± 0.07	0.47 ± 0.11	0.43 ± 0.10
BCVA Follow-up 2	0.28 ± 0.09	0.40 ± 0.09	0.34 ± 0.10
CS Baseline	1.21 ± 0.09	1.19 ± 0.15	1.20 ± 0.12
CS Follow-up 1	1.37 ± 0.09	1.31 ± 0.14	1.34 ± 0.12
CS Follow-up 2	1.49 ± 0.11	1.39 ± 0.15	1.44 ± 0.14

Baseline And Follow up Measurements of visual outcome:

A repeated measures ANOVA with Greenhouse-Geisser correction was conducted to assess changes in visual outcomes across three time points: baseline, follow-up 1, and follow-up 2. The results are presented in Table 15. There was a statistically significant improvement in Visual Acuity (VA) over time, from baseline (M = 0.62, SD = 0.10) to follow-up 2 (M = 0.36, SD = 0.16), $p < 0.001$. Best Corrected Visual Acuity (BCVA) also showed significant improvement from baseline (M = 0.57, SD = 0.10) to follow-up 2 (M = 0.32, SD = 0.16), $p = 0.002$. Contrast Sensitivity (CS) demonstrated significant improvement from baseline (M = 1.22, SD = 0.13) to follow-up 2 (M = 1.47, SD = 0.19), $p < 0.001$. These findings indicate that overall, patients showed significant improvement in VA, BCVA, and CS from baseline to final follow-up.

Visual outcome	Mean	Std. Deviation	N	Greenhouse Giesser(P)
VA Baseline	.6165	.09838	52	<0.001
VA Follow-up 1	.4583	.12961	52	
VA Follow-up 2	.3554	.15908	52	
BCVA Baseline	.5663	.09714	52	.002
BCVA Follow-up 1	.4125	.12981	52	
BCVA Follow-up 2	.3188	.16061	52	
CS Baseline	1.2156	.12997	52	<0.001
CS Follow-up 1	1.3631	.15332	52	
CS Follow-up 2	1.4688	.18827	52	

DISCUSSION

The present study examined the effect of early versus late initiation of eye patching therapy on visual acuity and contrast sensitivity among

children with anisometropic amblyopia. Children were divided into an early patching group aged 3–7 years and a late patching group aged 8–12 years. Overall, improvement in visual acuity, best-

corrected visual acuity and contrast sensitivity was observed during follow-up in both groups. However, the degree of improvement was greater among children who started patching at an earlier age. This finding is clinically important because anisometropic amblyopia develops during a period in which the visual system is still maturing. When one eye provides a persistently poorer retinal image because of unequal refractive error, the brain tends to favor the eye providing the clearer image. If this continues during childhood, visual development in the amblyopic eye may remain reduced. Patching the better-seeing eye encourages the child to use the amblyopic eye and provides greater stimulation to the visual pathways associated with that eye.

One of the main observations of the present study was the better response among children who started patching between 3 and 7 years of age compared with those who started between 8 and 12 years. This supports the importance of detecting and treating anisometropic amblyopia during the earlier years of visual development. The better improvement seen in younger children may be related to greater neural plasticity during the early years of life. During this period, the visual cortex is more responsive to changes in visual input. Correcting the unequal refractive error and encouraging use of the amblyopic eye through patching may therefore allow greater recovery of visual function. As children become older, visual cortical plasticity gradually decreases, although it does not disappear completely.

This interpretation is consistent with the review by Bui Quoc et al. (2023), who reported that traditional amblyopia treatments, including optical correction and fellow-eye occlusion, generally produce the greatest benefit when treatment is introduced early. The authors also emphasized that improvement can still occur in older children, which is important because older age should not automatically be considered a reason to withhold treatment. [26]

Yeritsyan et al. (2024), in a systematic review of amblyopia treatments in children aged seven years and younger, described patching as an

established treatment during the sensitive period of visual development. Their review emphasized the favorable response to treatment in younger children and the importance of intervention while the visual system retains a high degree of developmental plasticity. These reports support the present finding that the early patching group demonstrated greater visual improvement than the late patching group. Nevertheless, age should not be interpreted as the only factor determining treatment success. Baseline severity of amblyopia, refractive correction, adherence to treatment, duration of treatment and regular follow-up can also influence the final visual outcome. [27]

The effectiveness of patching reported in the present study is supported by Yao et al. (2020), who conducted a randomized clinical trial involving 103 children aged 3–13 years with anisometropic amblyopia. Children received binocular treatment, part-time patching or a combination of the two. At three months, amblyopic-eye visual acuity improved by approximately 0.28 logMAR in the patching group. Patching produced greater improvement in visual acuity than binocular game treatment alone. The findings of Yao et al. are particularly relevant to the present research because their participants were within a similar pediatric age range and specifically had anisometropic amblyopia. Their results strengthen the evidence that occlusion of the better-seeing eye remains an effective approach for improving amblyopic-eye visual acuity. [28]

Further support is provided by Chen et al. (2021), who performed a meta-analysis of randomized controlled trials comparing binocular treatment with patching. Six trials involving more than 1,300 eyes were included. Their analysis demonstrated meaningful improvement in BCVA following amblyopia treatment and confirmed that conventional patching continues to have an important role in childhood amblyopia management. Therefore, the improvement found in both groups in the present study agrees with the broader literature. The important difference in the present research is not simply whether patching works, but

whether starting patching earlier is associated with a greater degree of improvement. [29]

Sesma et al. (2023) studied Saudi children aged 6–12 years receiving treatment for unilateral amblyopia. The median BCVA improved from 0.8 logMAR at presentation to 0.45 logMAR at the final follow-up, and the overall treatment success rate was approximately 80%. In children with anisometropic amblyopia in that study, treatment outcomes were particularly favorable. The investigators concluded that occlusion therapy together with appropriate spectacle correction can result in significant visual recovery even among older children. This finding is relevant to the late-treatment group in the present study. Although their improvement was smaller than that observed in younger children, the presence of a significant response indicates that children aged 8–12 years should still be offered treatment when clinically appropriate. Therefore, the findings should not be interpreted to mean that patching after seven years of age is ineffective. Rather, they suggest that treatment at a younger age may provide a greater opportunity for visual recovery while meaningful improvement remains possible in older children. [30]

Best-corrected visual acuity is particularly important when evaluating anisometropic amblyopia because refractive error itself may influence uncorrected visual acuity. Assessment after appropriate refractive correction provides a better indication of the underlying amblyopic deficit. In the present study, BCVA improved progressively during follow-up in both groups, with greater improvement among children treated earlier. This suggests that the improvement was not merely the result of optical correction but represented improvement in visual performance of the amblyopic eye during treatment.

Recent systematic reviews continue to recognize optical correction followed, where necessary, by occlusion therapy as a central approach in childhood amblyopia management. Alrasheed and Aldakhil (2024) reviewed recent management options and concluded that

treatment generally begins by correcting refractive error and allowing a period of optical adaptation, followed by patching or other therapies when residual amblyopia remains. This has particular relevance to anisometropic amblyopia. Children should receive accurate refractive correction before the additional effect of patching is evaluated. Failure to adequately correct the anisometropia may underestimate treatment response or make it difficult to determine whether changes in vision are caused by spectacles, patching or both.

In addition to visual acuity, contrast sensitivity improved during follow-up in the present study. Improvement was observed in both groups, although the early patching group showed a greater overall increase. Contrast sensitivity provides information that is not fully captured by high-contrast visual acuity charts. A child may demonstrate an improvement in standard visual acuity while continuing to have difficulty detecting objects when contrast is reduced. For this reason, including contrast sensitivity provides a broader evaluation of visual recovery in amblyopia. [31]

Roy et al. (2023) directly investigated contrast sensitivity in children aged 5–15 years with anisometropic amblyopia. Participants were randomized to dichoptic video-game therapy or conventional occlusion therapy. In the patching group, contrast sensitivity increased significantly during the three-month treatment period, alongside a significant improvement in BCVA. Although dichoptic therapy produced a greater final improvement in contrast sensitivity in that particular trial, conventional patching itself still produced a statistically significant improvement. The findings reported by Roy et al. support the improvement in contrast sensitivity observed in the present study and show why assessment of treatment effectiveness should not rely only on visual acuity. Amblyopia affects several aspects of visual processing. Consequently, recovery of high-contrast letter acuity does not necessarily mean that all visual functions have returned to normal. The inclusion of contrast sensitivity in the present research therefore provides additional

information about functional recovery following patching therapy.

When the overall results are considered together, both age groups benefited from patching, but children receiving early treatment demonstrated the greater improvement. This pattern was observed in visual acuity, BCVA and contrast sensitivity. [32]

Liao et al. (2025) noted that early treatment remains preferable while also emphasizing continued visual plasticity beyond the traditional critical period. Likewise, recent systematic reviews have continued to support patching as an effective conventional therapy while acknowledging that treatment outcomes are influenced by several patient- and treatment-related factors. The findings of this study highlight the importance of early identification of refractive errors in children. Anisometropia may not always be noticed by parents because the child can function using the better-seeing eye. As a result, the condition may remain undiagnosed until school screening or a formal ophthalmological examination is performed. Early vision screening could allow anisometropia to be detected before a large amblyopic deficit develops. Appropriate spectacle correction should then be provided, followed by patching when clinically indicated. At the same time, children presenting at an older age should not be considered beyond treatment. The improvement observed in the late patching group, together with evidence from studies of older children, indicates that treatment can still provide useful visual improvement. Therefore, the practical message from the present study is twofold: treatment should preferably begin early, but treatment should not be denied simply because a child presents later. [33]

CONCLUSION

This study was done to compare early and late patching therapy in children with anisometropic amblyopia for visual acuity and contrast sensitivity. We found that patching therapy works in both groups. Visual acuity, BCVA and contrast sensitivity all improved after patching

from baseline to follow ups. However, the improvement was more in early patching group as compared to late patching group. At final follow up early group had better visual acuity and better contrast sensitivity and this difference was statistically significant. So from this study we conclude that early patching gives better results than late patching. The reason is that in early age visual system is more plastic so it responds better to occlusion. Therefore in clinical practice we should focus on early screening of children for refractive error and amblyopia and start patching as early as possible to get better visual recovery.

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