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# ASSESSMENT OF THE CLINICAL IMPACT OF AMBLYOPIA PATCHING THERAPY IN PATIENTS WITH DOWN SYNDROME

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## ABSTRACT
Down syndrome (trisomy 21) is accompanied by a high burden of eye disease, and amblyopia is one of the few problems that can be treated if it is found. Evidence for patching in this group is thin, because most trials leave out children with intellectual disability. We assessed the clinical impact of part-time occlusion therapy in children and adolescents with Down syndrome and amblyopia. In this prospective longitudinal study at the Strabismus Unit of Myo hospital, Lahore, Pakistan (September 2024 to May 2025), 30 patients aged 8-18 years were enrolled (18 aged 8-12 years; 18 male). After refraction, the better eye was patched for 4 h/day, 5 days/week, together with 2 h/day of near visual activities. Best-corrected visual acuity (logMAR) and refractive prescription were recorded at baseline, 1 month and 3 months and analyzed by repeated-measures ANOVA with Greenhouse-Geisser correction and pairwise comparisons. Twenty patients were hypermetropic and 10 were myopic. Mean logMAR acuity changed from 0.55 ± 0.27 at baseline to 0.54 ± 0.27 at 1 month and 0.41 ± 0.26 at 3 months (P = 0.041). The change was not significant at 1 month (mean difference 0.010, P = 0.249) but was significant at 3 months (0.142 logMAR, 95%CI 0.049-0.234, P = 0.002), about 1.4 chart lines. The mean recorded refractive prescription also decreased, from 2.13 D at baseline to 1.72 D at 3 months (P = 0.047). Poor attendance and limited cooperation were the main practical difficulties. Patching combined with refractive correction and near activities was followed by a measurable gain in visual acuity within three months, with the benefit appearing after the first month. Because there was no control group, part of the change may reflect refractive adaptation and practice effects, and larger controlled studies with longer follow-up are needed.

**KEYWORDS:** Down syndrome; Amblyopia; Patching therapy; Occlusion; Visual acuity; Refractive error

## INTRODUCTION
Down syndrome (DS) is caused by an extra whole or partial copy of chromosome 21 and is one of the most common chromosomal conditions at birth (Antonarakis et al., 2020; Bull et al., 2022). Eye disease is part of the picture for most people with the condition. A recent meta-analysis put the pooled frequency of refractive error at about 70% and of strabismus at about 31% (Beresford-Webb et al., 2025), and earlier clinical series also describe nystagmus, lens opacities, keratoconus, nasolacrimal duct obstruction and poor accommodation (Roizen et al., 1994; Creavin and Brown, 2009; Haseeb et al., 2022). For a child who already struggles with learning, language and independence, a visual problem that goes untreated can make everything else harder (Postolache et al., 2021).
Amblyopia is reduced vision in one or both eyes that cannot be explained by eye disease alone and that arises when the brain receives a blurred or conflicting image during visual development. It is estimated to affect about 1.4% of people worldwide (Fu et al., 2020). Its usual causes are strabismus, a difference in refractive error between the two eyes (anisometropia), or both (Holmes and Clarke, 2006). Children with DS have every reason to be at higher risk. Their refractive errors are common and widely spread, and the normal process by which refractive error shrinks in early childhood (emmetropization) often fails (Cregg et al., 2003; Al-Bagdady et al., 2011). Hypermetropia is the typical finding (Haugen et al., 2001), accommodation is frequently weak (Stewart et al., 2007a) and strabismus, mostly esotropia, is frequent (Woodhouse et al., 1997; Haseeb et al., 2022). How often amblyopia is reported in DS differs a great deal between series, partly because measuring acuity in these children is difficult and probably leads to under-diagnosis (Haseeb et al., 2022).

In typically developing children the treatment pathway is well mapped. Refractive correction comes first, and if a deficit remains, the better eye is patched for between two and six hours a day, often with near tasks (Repka et al., 2003; Holmes et al., 2003; Wallace et al., 2006). Response falls with age but does not vanish; older children and teenagers can still gain (Scheiman et al., 2005; Holmes et al., 2011). Results depend heavily on how much patching is actually worn (Awan et al., 2005; Loudon et al., 2006; Stewart et al., 2007b). The reviews that pull this evidence together say little about children with DS (Papageorgiou et al., 2019; Taylor and Elliott, 2014). As a result, many clinicians hesitate to patch a child with DS, and parents are left without clear advice.

We therefore set out to assess the clinical impact of patching therapy on visual acuity and refractive findings over three months in children and adolescents with DS and amblyopia attending a tertiary strabismus unit in Lahore, Pakistan.

## MATERIAL AND METHODS

### Study design and setting

This was a prospective longitudinal study carried out at the Strabismus Unit, Department of Ophthalmology, Myo Hospital, Lahore, from September 2024 to May 2025.

### Participants

We enrolled 30 patients (60 eyes) with DS and a diagnosis of amblyopia, using convenience sampling. Patients of either sex aged 8-18 years with any type of amblyopia and any refractive error were eligible. We excluded patients with mental or motor retardation beyond that expected with DS, other neurodevelopmental disorders, systemic disease, congenital glaucoma, retinitis pigmentosa, previous ocular surgery, or a previous skin reaction to patch adhesive.

### Clinical assessment

Visual acuity was measured with a Brien Holden logMAR chart. Each line has five letters and each letter scores 0.02 logMAR, so one line equals 0.1 logMAR. Objective refraction was done with a Topcon autorefractometer and was followed by subjective refraction to find the best-corrected visual acuity (BCVA). An interocular difference of three to five lines was classed as moderate amblyopia and more than five lines as severe. Amblyopia associated with strabismus, anisometropia or both was included. Every patient had a fundus examination with a Heine ophthalmoscope and an orthoptic work-up before treatment began.

### Intervention

The better (fixing) eye was patched for 4 hours a day, five days a week. During patching the child did near visual activities for two hours a day, such as crafts, colouring, tracing, reading, workbook games and computer-based tasks. Parents were shown how to apply the patch and supervise the activities.

### Follow-up and outcomes

Patients were reviewed at 1 month and at 3 months (12 weeks). At each visit we repeated logMAR acuity and refraction and noted how well the child had followed the programme. The outcomes were BCVA of the amblyopic eye (logMAR) and the refractive prescription, compared across baseline, 1 month and 3 months.

### Statistical analysis

Data were entered and analyzed in IBM SPSS version 23. Normality was checked with the Shapiro-Wilk test ($P > 0.05$ taken as normal). Changes over time were tested by repeated-measures ANOVA, using the Greenhouse-Geisser correction, followed by pairwise comparisons with adjustment for multiple testing. Values are mean ± standard deviation unless stated, and $P < 0.05$ was considered significant. The unit of analysis was the patient ($n = 30$).

### Ethics

The aims and design of the study were explained to the patients and their parents or guardians, and written and verbal consent were obtained before enrolment. [Insert institutional ethics committee name and approval number.] The study followed the principles of the Declaration of Helsinki.

## RESULTS

Thirty patients completed the baseline assessment and both follow-up visits. Eighteen (60.0%) were aged 8-12 years and 12 (40.0%) were aged 13-18 years; 18 (60.0%) were male and 12 (40.0%) female. Hypermetropia was more common than myopia (20 patients, 66.7%, versus 10 patients, 33.3%) (Table 1). Baseline visual acuity was normally distributed (Shapiro-Wilk, $P > 0.05$), which justified parametric testing.

**Table 1.** Baseline characteristics of the 30 patients with Down syndrome and amblyopia.

| Characteristic | Category | n | % |
|---|---|---|---|
| Age group | 8-12 years | 18 | 60.0 |
| | 13-18 years | 12 | 40.0 |
| Sex | Male | 18 | 60.0 |
| | Female | 12 | 40.0 |

| Characteristic | Category | n | % |
|---|---|---|---|
| Refractive error | Hypermetropia | 20 | 66.7 |
| | Myopia | 10 | 33.3 |

**Visual acuity**

Mean logMAR acuity was 0.55 ± 0.27 at baseline, 0.54 ± 0.27 at one month and 0.41 ± 0.26 at three months (Table 2, Figure 1). The overall effect of time was significant (Greenhouse-Geisser P = 0.041). Pairwise testing showed that the one-month value did not differ from baseline (mean difference 0.010 logMAR, P = 0.249). By three months, however, acuity was better than at baseline by 0.142 logMAR (95%CI 0.049-0.234, P = 0.002) and better than at one month by 0.132 logMAR (95%CI 0.044-0.219, P = 0.002) (Table 3). A change of 0.14 logMAR is a little more than one chart line; on a Snellen scale it moves the mean from roughly 20/70 to roughly 20/50.

**Refractive prescription**

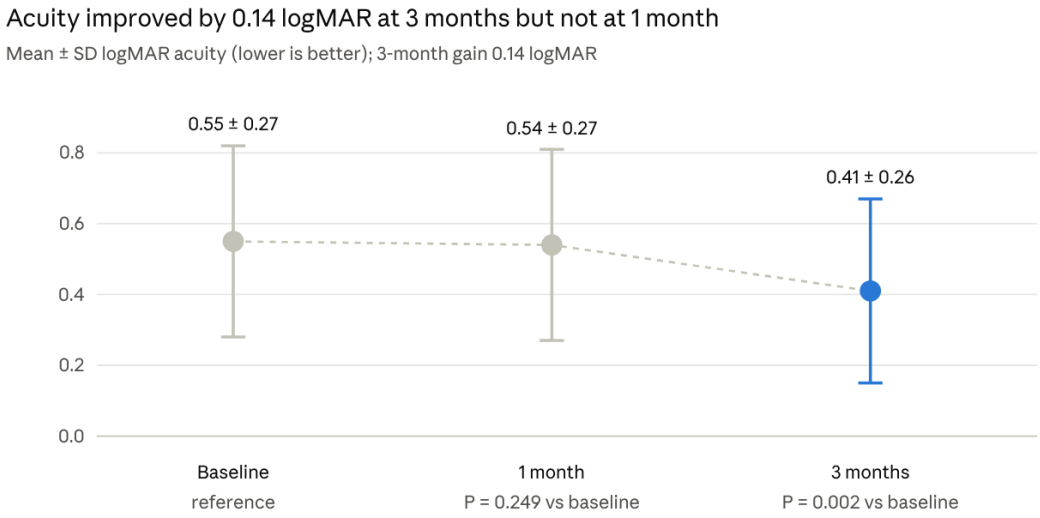
The mean recorded prescription was 2.13 D at baseline, 2.12 ± 1.40 D at one month and 1.72 ± 1.32 D at three months (Greenhouse-Geisser P = 0.047). As with acuity, nothing changed between baseline and one month (difference 0.017 D, P = 0.482), whereas the three-month value was lower than both baseline (0.417 D, 95%CI 0.310-0.524, P < 0.001) and one month (0.400 D, 95%CI 0.301-0.499, P < 0.001) (Table 3, Figure 2).

**Table 2.** Visual acuity and refractive prescription at baseline and follow-up (mean ± SD, n = 30).

| Time point | logMAR visual acuity | Refractive prescription (D) |
|---|---|---|
| Baseline | 0.55 ± 0.27 | 2.13 ± [SD to be confirmed] |
| 1 month | 0.54 ± 0.27 | 2.12 ± 1.40 |
| 3 months | 0.41 ± 0.26 | 1.72 ± 1.32 |
| P (Greenhouse-Geisser) | 0.041 | 0.047 |

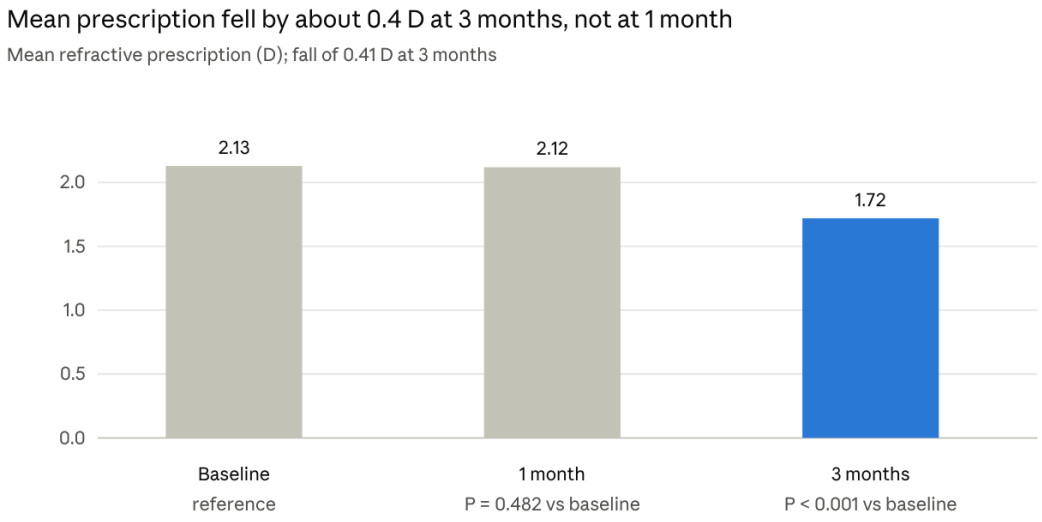
**Table 3.** Pairwise comparisons between time points (difference = earlier minus later value, so a positive value means a lower logMAR or prescription at the later visit).

| Outcome | Comparison | Mean difference | SE | 95%CI | P |
|---|---|---|---|---|---|
| logMAR acuity | Baseline vs 1 month | 0.010 | 0.006 | -0.004 to 0.024 | 0.249 |
| | Baseline vs 3 months | 0.142 | 0.036 | 0.049 to 0.234 | 0.002 |
| | 1 month vs 3 months | 0.132 | 0.034 | 0.044 to 0.219 | 0.002 |
| Prescription (D) | Baseline vs 1 month | 0.017 | 0.012 | -0.013 to 0.046 | 0.482 |
| | Baseline vs 3 months | 0.417 | 0.042 | 0.310 to 0.524 | < 0.001 |
| | 1 month vs 3 months | 0.400 | 0.039 | 0.301 to 0.499 | < 0.001 |




Study data, n = 30 patients; error bars show SD; P values are pairwise comparisons against baseline

**Figure 1.** Mean logMAR visual acuity at baseline, 1 month and 3 months (lower values mean better vision).




Study data, n = 30 patients; P values are pairwise comparisons against baseline

**Figure 2.** Mean refractive prescription (D) at baseline, 1 month and 3 months.

## DISCUSSION

In this group of children and adolescents with Down syndrome, visual acuity in the amblyopic eye was better after three months of patching combined with near activities, but not after one month. The average gain of 0.14 logMAR is a little over one line on the chart. That is a modest improvement, and it is encouraging for a group that is often assumed not to respond.

The size of the gain makes sense when set beside the trial literature. In typically developing children aged under seven with moderate amblyopia, two to six hours of daily patching produced average gains of about 2.4 lines (Repka et al., 2003), and response falls steadily with age (Holmes et al., 2011). Our patients were between 8 and 18 years old, an age range in which gains are smaller but still real (Scheiman et al., 2005; Scheiman et al., 2008). Children with DS carry further handicaps that are specific to the condition: poor accommodation that spectacles do not fully correct (Cregg et al., 2003; Stewart et al., 2007a), limited attention for near tasks, and difficulty with letter charts. A gain of about one line, therefore, is not out of line with what might be expected.

The lack of change at one month deserves a comment. We did not measure how much patching each child actually wore, so we cannot say whether the early flat period reflects slow uptake at home, the time needed for the child to learn the near tasks, or simply the slow adaptation to a new refractive correction, which is known to take weeks to

months and can account for sizeable gains on its own (Stewart et al., 2004; Taylor and Elliott, 2014). Whatever the reason, the practical lesson is that a child with DS should not be judged a non-responder after four weeks.

Compliance is the likeliest bottleneck. Dose-monitoring studies show that the amount of patching worn drives the result and that families often fall well short of what is prescribed (Awan et al., 2005; Stewart et al., 2007b). Low parental education and poor starting acuity predict poor adherence, and a child-friendly education package improved it in a randomized setting (Loudon et al., 2006). In our clinic the main difficulties were missed follow-up visits and children who would not keep the patch on. Time spent coaching parents, and simple tools such as reward charts or a diary, are likely to be worth more than any change in the prescribed hours.

The pattern of refractive error matched earlier work. Hypermetropia outnumbered myopia, as in other DS cohorts (Cregg et al., 2003; Haugen et al., 2001; Al-Bagdady et al., 2011), and refractive error was frequent overall, in line with recent pooled estimates (Beresford-Webb et al., 2025). The drop in mean prescription between baseline and three months needs careful reading. In children with DS, refractive error usually changes little during childhood and the teenage years (Al-Bagdady et al., 2011), and there is no good biological reason to expect occlusion of the better eye to reduce the refractive error of the amblyopic one. A more likely explanation is measurement: as vision improves and the child cooperates better, subjective refraction becomes more reliable, and a different end-point may be reached. We therefore regard this result as exploratory and do not claim that patching alters refraction.

This study has clear limits. There was no control group, so we cannot separate the effect of patching from that of refractive adaptation, practice on the chart, or the natural course of the condition. The sample was small and recruited by convenience from one centre. Follow-up lasted only three months, so we cannot say whether the gain is kept or whether it would continue to grow. Compliance was reported rather than measured with an occlusion dose monitor, and we did not analyze results separately by amblyopia type, severity or age band. Finally, the average change of 0.14 logMAR is close to the test-retest variability reported for children's acuity testing, which is about 0.125 logMAR for a single measurement (Holmes et al., 2001); averaging across 30 patients reduces random error but does not remove systematic learning effects. Larger, controlled trials with objective compliance monitoring and at least six to twelve months of follow-up are the obvious next step.

Taken together, the findings support offering patching, with spectacles and near activities, to children and adolescents with DS who have amblyopia, and giving it at least three months before judging the result. They also suggest that effort should go into early detection and into supporting families, because it is the child’s time wearing the patch that decides the outcome.

## CONCLUSIONS

In patients with Down syndrome and amblyopia, patching therapy with near activities was followed by a significant improvement in visual acuity at three months, but not at one month. Hypermetropia was the commonest refractive error. Poor adherence was the main practical barrier. Because the study was uncontrolled and short, the results should be treated as encouraging rather than conclusive.

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