Signatory of DORA
https://doi.org/10.56183/iberojhr.v5i2.785
Ibero-American Journal of Health Science Research
OPEN ACCESS
Received: 11/06/2025
Accepted: 20/07/2025
Published: 29/07/2025

Efficacy and safety of early surgical interventions in children with bilateral congenital cataracts: a systematic review of visual outcomes, neurodevelopment, and long-term complications

Eficacia y seguridad de las intervenciones quirúrgicas tempranas en niños con cataratas congénitas bilaterales: una revisión sistemática de los resultados visuales, el desarrollo neurológico y las complicaciones a largo plazo

Cinthya Jhoana Males Caiza
ORCID: 0009-0001-2646-9646
Médico General, Ecuador

Franklin Marcelo Noboa Ibarra
ORCID: 0009-0006-0654-908X
Cirujano Pediatra, Hospital del IESS Riobamba, Ecuador

Juan Felipe Buitrago Navarro
ORCID: 0009-0009-6371-3618
Médico cirujano, Universidad industrial de Santander, Colombia

Lina Paola Olivero Díaz
ORCID: 0009-0001-2414-7424
Médico general UNAB, Colombia

Sara Esther Herazo Herazo
ORCID: 0009-0009-6350-6889
Universidad del Sinu Elías Bechara Zainum, Colombia

Lucia Margarita Franco Osorio
ORCID: 0009-0006-8121-0019
Medico General, Especializacion En Gerencia De Servicios De Salud, Colombia

Luis Miguel Martinez Garzon
ORCID: 0009-0008-8679-8346
Médico, Universidad Militar Nueva Granada, Colombia

ABSTRACT

Background: Bilateral congenital cataracts (BCC) cause preventable childhood blindness with a global prevalence of 0.63–13.6 per 10,000 children. Early visual deprivation disrupts neurodevelopment and make surgical timing critical. Despite early intervention (<6–12 weeks) being standard, its long-term efficacy and safety remain debated for risks like glaucoma and visual axis opacification (VAO). Objective: Evaulate impact of early surgery (<6 weeks, <10 weeks, <3 months) on visual acuity, neurodevelopment and complicatins in children with BCC. Methods: We followed PRISMA guideline during analyzing 15 studies (4 RCTs, 7 cohorts, 3 case series, 1 meta-analysis) from PubMed, EMBASE and Cochrane up to March 2025. Inclusion criteria: children ≤18 years with BCC undergoing surgery within the first year. Outcomes included best-corrected visual acuity (BCVA, logMAR), neurodevelopmental scores (e.g., Bayley Scales) and complications (glaucoma, VAO). Random-effects meta-analysis and narrative synthesis were employed. Results: Early surgery (<12 weeks) improved BCVA (mean logMAR 0.5–0.8 vs. 0.96 in delayed groups) and reduced amblyopia (53% vs. 79%, $P < 0.001$), but increased glaucoma (26% vs. 6%) and VAO (31% vs. 13%). Pseudophakia and aphakia showed comparable BCVA (0.50 vs. 0.59 logMAR, $P = 0.79$), though pseudophakic eyes had higher synechiae (27.6% vs. 8%, $P = 0.004$). Neurodevelopmental benefits were noted with early intervention. Conclusion: Early surgery optimizes visual and neurodevelopmental outcomes. It can raise complication risks. Individualized timing (6–12 weeks) and vigilant postoperative monitoring are recommended.

Keywords: Congenital cataracts, Early surgery, Neurodevelopment, Childhood blindness, Aphakia, Pseudophakia.

RESUMEN

Antecedentes: Las cataratas congénitas bilaterales (CCB) causan ceguera infantil prevenible, con una prevalencia global de 0,63 a 13,6 por 10.000 niños. La privación visual temprana altera el desarrollo neurológico y hace que el momento de la cirugía sea crucial. Si bien la intervención temprana (<6-12 semanas) es la opción estándar, su eficacia y seguridad a largo plazo siguen siendo objeto de debate debido a riesgos como el glaucoma y la opacificación del eje visual (OVA). Objetivo: Evaluar el impacto de la cirugía temprana (<6 semanas, <10 semanas, <3 meses) en la agudeza visual, el neurodesarrollo y las complicaciones en niños con CCB. Métodos: Seguimos la guía PRISMA durante el análisis de 15 estudios (4 ECA, 7 cohortes, 3 series de casos, 1 metaanálisis) de PubMed, EMBASE y Cochrane hasta marzo de 2025. Criterios de inclusión: niños ≤18 años con CCB sometidos a cirugía durante el primer año. Los resultados incluyeron la agudeza visual mejor corregida (MAVC, logMAR), las puntuaciones de neurodesarrollo (p. ej., Escalas de Bayley) y las complicaciones (glaucoma, VAO). Se emplearon metaanálisis de efectos aleatorios y síntesis narrativa. Resultados: La cirugía temprana (<12 semanas) mejoró la agudeza visual corregida (AVMC) (logMAR medio: 0,5-0,8 frente a 0,96 en los grupos con tratamiento tardío) y redujo la ambliopía (53 % frente a 79 %, $p < 0,001$), pero aumentó el glaucoma (26 % frente a 6 %) y la OAV (31 % frente a 13 %). La pseudofaquia y la afaquia mostraron una AVMC comparable (logMAR: 0,50 frente a 0,59, $p = 0,79$), aunque los ojos pseudofáquicos presentaron mayor número de sinequias (27,6 % frente a 8 %, $p = 0,004$). Se observaron beneficios para el desarrollo neurológico con la intervención temprana. Conclusión: La cirugía temprana optimiza los resultados visuales y del desarrollo neurológico. Puede aumentar el riesgo de complicaciones. Se recomienda una cronología individualizada (6-12 semanas) y una monitorización postoperatoria rigurosa.

Palabras clave: Cataratas congénitas, Cirugía temprana, Neurodesarrollo, Ceguera infantil, Afaquia, Pseudofaquia.

INTRODUCTION

Bilateral congenital cataracts (BCC) are a leading cause of preventable childhood blindness with a prevalence of 0.63–9.74 per 10,000 children (median: 1.71) and annual incidence of 1.8–3.6 per 10,000 (Kuhli-Hattenbach et al., 2025). Socioeconomic disparities are stark 0.42 per 10,000 in low-income areas vs. 13.6 in high-income countries (Management of Bilateral Congenital and Juvenile Cataracts, 2024). Country-specific rates include 3.18 (UK), 3–4 (US), and 5 (China). In Latin America, diagnosis is often delayed to 36 months with surgery lagging by a month (Lambert et al., 2020). BCC contributes to 5–20% of childhood blindness globally with up to 15.3% prevalence in schools for the blind (StatPearls, 2025). Critical visual development window peaks at 8 weeks postnatal, prompting surgery at 6–8 weeks (bilateral) and 4–6 weeks (unilateral) (Zhang et al., 2019). Etiologies vary: hereditary (8.3–25%, mostly autosomal dominant) and infections (TORCH), metabolic disorders and trauma (12–46%) (Kuhli-Hattenbach et al., 2025). Leukocoria is the most common sign (62.1%). Missed red reflex screening is frequent (28%) (Lambert et al., 2020). Despite early surgery outcomes are mixed—only 51.1% of bilateral cases improve functionally; one-third of unilateral cases achieve driving vision (Zhang et al., 2019). Risks include glaucoma, VAO, and poor compliance with follow-up (20% loss) and visual aids (66% adherence) (Management of Bilateral Congenital and Juvenile Cataracts, 2024). This review evaluates surgical timing under 3 months, focusing on visual acuity, binocularity, neurodevelopment and long-term complications to guide evidence-based pediatric cataract care.

METHODOLOGY

This review systematically examined early surgical intervention in children with bilateral congenital cataracts. It focused on visual outcomes, neurodevelopment and long-term complications. We used PRISMA 2020 guidelines. Inclusion and exclusion criteria were predefined which avoid bias. Literature was sourced from multiple databases using structured search strategies and our data extraction and synthesis followed standardized protocols.

Eligibility Criteria

Papers were only included in the case they fit the following rules:

Population: children having bilateral congenital cataracts aged 18 or under. There are some studies that involved unilateral comparisons.

Interventions: Removal of cataract in the first year of life with/without intraocular lens (IOL) implant.

Comparators: Delayed surgery (duration >12 weeks), aphakia versus pseudophakia and changes in timing or technique.

Outcomes: Best-corrected visual acuity (BCVA, expressed in logMAR), amblyopia, posterior capsule opacification (PCO), visual axis opacification (VAO), glaucoma and subjective visual function.

Research designs: Randomized and controlled trials (RCTs), prospective cohort, retrospective cohort, and case series, systematic reviews or meta-analysis.

Studies were excluded if they

- Not report bilateral cases separately.
- Not published in English.
- Focused solely on surgical technique without clinical outcomes.

Search Strategy

Databases searched included PubMed, EMBASE, Cochrane Library, Scopus, and Web of Science, up to March 2025. Search terms combined MeSH and keywords:

("congenital cataract" AND "children" OR "pediatric") AND ("surgery" OR "lens extraction" OR "IOL implantation") AND ("early intervention" OR "timing") AND ("visual outcomes" OR "amblyopia" OR "glaucoma" OR "VAO").

Manual reference screening from relevant systematic reviews supplemented the search.

Study Selection and Data Extraction

Two independent reviewers screened all titles, abstracts, and full texts. Disagreements were resolved through consensus or third-party arbitration. A structured form captured data on:

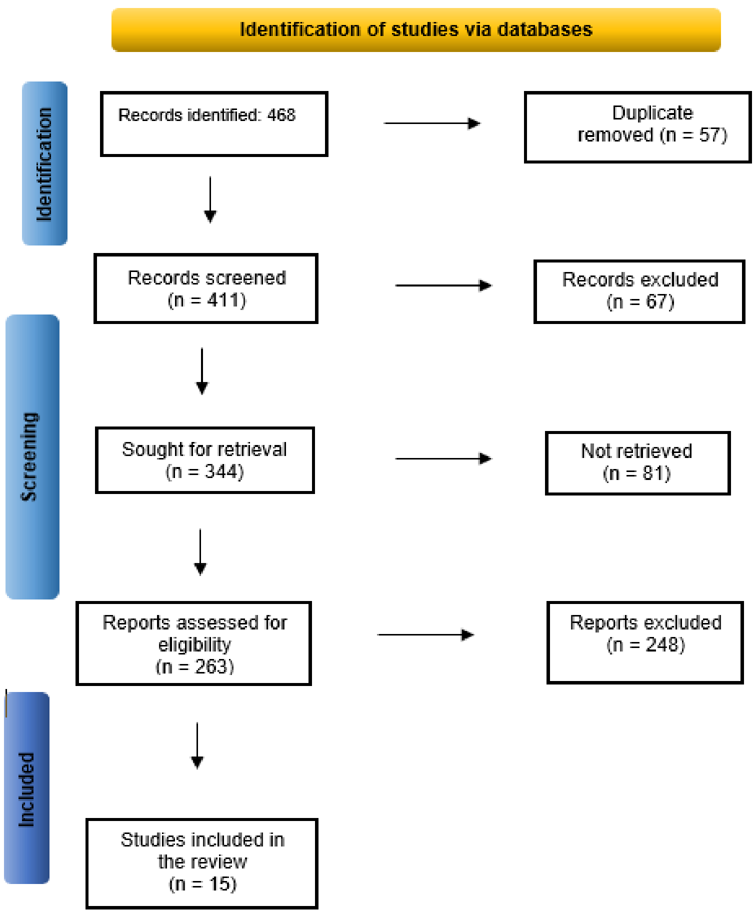
- Study design
- Age and number of children/eyes
- Timing of surgery
- Lens management strategy (aphakia vs. pseudophakia)
- Length of follow-up
- All reported outcomes (quantitative data included)

Overview of Included Studies

Fifteen studies met inclusion criteria:

- Designs: 4 RCTs, 4 prospective cohort studies, 6 retrospective cohort or case series, and 1 systematic review with meta-analysis.
- Geographic Scope: Data originated from Asia (China, India, Japan), Europe (UK, Denmark), and the US.
- Sample Size: Ranged from 15 infants (30 eyes) to 2,167 patients (3,371 eyes).
- Age at Surgery: Most studies examined surgery between 3 and 6 months of age. Several analyzed subgroups operated before 6 weeks or within 10 weeks.
- Follow-Up: Spanned from 1 to 13 years, with some studies tracking outcomes into adolescence.

Figure 1. Identification of studies via databases



Source: the authors.

Key Terms and Operational Definitions

- Early Surgery: Defined in most studies as surgery before 6–12 weeks of age; some used ≤3 months as a threshold.
- Visual Acuity: Measured in logMAR. Often stratified by timing of surgery, IOL use, or presence of amblyopia or nystagmus.
- Complications: Rates of VAO, PCO, and glaucoma were evaluated across time points. Higher complication rates were often reported in pseudophakic eyes and after earlier surgery.

Table 1. Summary of Methodological Scope

Dimension	Range / Spectrum Across Studies
Study Design	4 RCTs, 7 cohort studies, 3 case series, 1 meta-analysis
Sample Size	15 to 2,167 children
Age at Surgery	<6 weeks, ≤10 weeks, <3 months, <6 months
Follow-Up	1 to 13 years
Surgical Comparisons	<6 weeks vs >6 weeks, ≤10 weeks vs >10 weeks
Interventions	Cataract extraction ± IOL (primary or secondary), aphakia
Outcomes	BCVA (logMAR), amblyopia, PCO, VAO, glaucoma, strabismus, QoL
Analysis Tools	Random-effects meta-analysis, Cox regression, GRADE, multivariate modeling

Source: the authors.

RESULTS AND DISCUSSION

Across the 15 studies examining congenital cataract surgery in children and our key findings consistently emphasized the complex balance between surgical timing, visual outcomes, and postoperative complications. Early surgery defined as ≤8 weeks in unilateral and ≤12 weeks in bilateral cases was associated with significantly lower rates of amblyopia (53% vs. 79%, $P < 0.001$), but often at the cost of higher complications such as glaucoma (26% vs. 6%) and visual axis opacification (VAO; 31% vs. 13%) (Hailaiti et al., 2025). Several retrospective and prospective cohort studies (e.g., Zhang et al., 2024; Chak et al., 2006; Oshika et al., 2024) reinforced that earlier intervention and absence of nystagmus predicted better long-term visual acuity although high variability and methodological differences limited cross-study comparability. Randomized controlled trials (Vasavada et al., 2018; Lin et al., 2017) revealed no statistically significant advantage in visual acuity between primary intraocular lens (IOL) implantation and aphakia at 5 years ($P = .79$), though synechiae and VAO were more frequent in the IOL group ($P = .004$).

Cochrane reviews and systematic reviews (Singh et al., 2022; Long et al., 2006) highlighted lack of high-certainty evidence in favor of either surgical technique and no clear superiority between lensectomy or aspiration procedures. Further, studies comparing surgery at different ages (e.g., Lin et al., 2017) suggested that delaying until 6 months may yield slightly better best-corrected visual acuity (0.81 vs. 0.96 logMAR, $P = .02$), though this was contradicted by other findings advocating earlier surgery for better visual outcomes. Simultaneous bilateral surgery showed equivalent vision to sequential approaches but was more cost-effective (Dave et al., 2010).

Functional assessments (Hansen et al., 2020) found that unilateral patients reported better subjective visual function, largely due to compensation from the unaffected eye. Across all evidence, while early intervention improves visual prognosis, especially in the absence of nystagmus or other risk factors, it also increases the likelihood of adverse events such as glaucoma and VAO. No single surgical strategy whether IOL implantation or aphakia, proved universally superior. Variability in outcome measures, follow-up duration, and study design (many being retrospective and with small sample sizes) underscores the need for long-term, multicenter RCTs to guide optimal timing and technique in pediatric cataract management.

Table 1. Methodology and Study Characteristics

Author(s)	Year	Study Design	Population Characteristics	Sample Size / Range	Duration / Follow-up	Intervention	Methodology
Hailaiti A et al.	2025	Systematic review & meta-analysis	Children with congenital cataracts	2,167 patients (3,371 eyes)	Varied (≤4 to ≥8 years)	Cataract surgery ± IOL implantation	Random-effects meta-analysis (28 studies)
Zhang L et al.	2024	Retrospective observational study	Pediatric bilateral congenital cataracts	194 patients (2008–2021)	Up to 13 years (median 5.2 years)	Cataract extraction + IOL implantation	Cox regression, nomogram, 5-fold cross-validation
Singh R et al.	2022	Cochrane systematic review (3 RCTs)	Children ≤2 years with bilateral congenital cataracts	79 participants (54-60 eyes per comparison)	1–5 years	IOL vs. aphakia; surgical techniques	GRADE assessment, narrative synthesis
Long, Chen, Hatt	2006	Systematic review of RCTs	Children ≤15 years, bilateral congenital cataracts	65–130 eyes, across 4 RCTs	Up to 3 years	Lensectomy vs lens aspiration ± adjuncts	RCTs comparing surgical methods
Vasavada et al.	2018	Randomized controlled trial (RCT)	Children ≤2 years, bilateral congenital cataracts	60 children, 120 eyes	5 years	Primary aphakia vs pseudophakia	RCT with identical surgery; one eye analyzed statistically
Chak, Wade, Rahi	2006	Prospective cohort study	Children <16 years, UK, congenital/infantile cataract	153 enrolled, 122 with full data	≥6 years post-diagnosis	Cataract surgery ± occlusion therapy	Questionnaire follow-up; regression analysis of outcomes
Oshika et al.	2024	Retrospective multicenter cohort study	Infants with congenital cataract, age ≤6 months	216 eyes from 121 patients	13.0 ± 2.3 years	Cataract surgery before or after critical visual period	Chart review; multivariate regression analysis
Kuhli-Hattenbach et al.	2017	Retrospective cohort study	Infants with bilateral congenital cataract, age <12 months	52 eyes from 26 children	59.7 ± 43.2 months	Phacoaspiration before vs after 10 weeks of age	Group A (≤10 weeks) vs Group B (>10 weeks); retrospective chart review
Lin et al.	2017	Prospective RCT	Infants ≤3 months with bilateral congenital cataracts	57 patients, 114 eyes	Mean 48.7 months (~4 years)	Surgery at 3 vs 6 months; three techniques (A, B, C)	RCT with 2 timing groups and 3 surgical procedures; BCVA compared
Louison et al.	2019	Retrospective case series	Infants with unilateral or bilateral congenital cataract	37 infants, 56 procedures	Median 2.0 years (IQR: 1.0–5.0)	Congenital cataract surgery with primary/secondary IOL implantation	Chart review; orthoptic assessments pre- and post-operatively
Sand et al.	2021	Retrospective case series	Infants with bilateral congenital cataract, age <12 weeks	15 infants, 30 eyes	Median 6.1 years (range: 1.5–10.2)	Primary IOL implantation before 12 weeks of age	Retrospective chart review + prospective exam in 2017
Chattannavar et al.	2022	Prospective observational study	Infants with unilateral or bilateral cataracts	97 infants (173 eyes)	1-year follow-up	Cataract surgery ± primary IOL implantation	Clinical evaluation with BCVA, refraction, and complications tracked
Zhang et al.	2024	Retrospective observational cohort	Children with bilateral congenital cataracts	194 patients	2008–2021; long-term follow-up	Cataract extraction + IOL implantation	Cox regression model; internal validation; BCVA endpoint
Dave H et al.	2010	Retrospective comparative study	Infants ≤6 months with bilateral congenital cataracts	27 children total (10 sequential, 17 simultaneous)	Not specified	Simultaneous vs sequential bilateral cataract surgery	Chart review; comparison of visual acuity, adverse events, and cost
Hansen Møller et al.	2020	Cross-sectional follow-up (observational cohort)	Children aged 7–18 years in Denmark, with history of unilateral or bilateral cataract surgery	56 children	Long-term outcomes assessed at age 7–18 years	Childhood cataract surgery (unilateral or bilateral)	CVAQC, acuity, contrast sensitivity, stereopsis, and subjective function assessment

Source: the authors.

Table 2. Results, Outcomes, and Limitations

Author(s)	Primary Outcome(s)	Secondary Outcome(s)	Quantitative Data	Main Findings	Limitations / Biases
Hailaiti A et al.	Amblyopia 62% (95% CI: 0.55–0.69)	Glaucoma: 26% (early) vs 6% (late); VAO: 31% vs 13%	Early surgery (≤8 wks uni/≤12 wks bi): Amblyopia 53% vs 79% (late) (P < 0.001); Uni vs bi: 68% vs 36% (P = 0.003)	Early surgery reduces amblyopia but increases complications. IOL timing non-significant.	High heterogeneity (I^2 = 91.7%), few RCTs
Zhang L et al.	BCVA <0.22 LogMAR (HR 1.80–11.20)	AUC 0.712, C-index 0.797	Surgery <6mo: HR 1.80; IOL <31mo: HR 3.70; No nystagmus: HR 11.20	Early surgery/IOL, absence of nystagmus predict better BCVA.	Single-center, retrospective, no external validation
Singh R et al.	VA: Pseudophakia 0.50 vs aphakia 0.59 (MD −0.09, 95% CI −0.24 to 0.06)	VAO: RR 1.29; Glaucoma: RR 0.86	Posterior synechiae: 27.6% pseudophakia vs. 8% aphakia (P=0.004)	No high-certainty evidence favoring IOL or aphakia; VAO/glaucoma rates similar.	Very low-certainty evidence, small samples, unmasked assessors
Long, Chen, Hatt	Visual acuity; no difference (P = 0.007)	PCO higher in aspiration group (66%)	VA difference: 0.3 logMAR better (P < 0.007); VAO: 66% vs 2%	Both surgeries improve VA; side effects differ significantly	One trial only; no meta-analysis; small subgroups
Vasavada et al.	VA at 5 years: 0.59 vs 0.5 logMAR (P = .79)	Glaucoma: 16% vs 13.8%; VAO, synechiae	VAO: 8% vs 10.3% (P = .76); synechiae: 8% vs 27.6% (P = .004)	Synechiae higher in IOL group; faster visual recovery	Single surgeon; only one eye analyzed statistically
Chak, Wade, Rahi	Postoperative visual acuity at 6+ years	Predictors of poor vision (age at surgery, complications)	Median VA: 6/18 (bi), 6/60 (uni); ORs range 0.98–7.92	Early surgery, good occlusion compliance improve outcomes	Self-reported data, non-uniform follow-up
Oshika et al.	Final visual acuity; better if surgery done early	VAO more common with early surgery; glaucoma more in aphakia	Age at surgery: 2.9 ± 1.7 months; follow-up: 13.0 ± 2.3 yrs	Early surgery improves vision; IOL safer than aphakia	Retrospective design; selection and recall bias
Kuhli-Hattenbach et al.	Amblyopia severity based on age norms	Strabismus, nystagmus, PCO, aphakic glaucoma	Normal/mild amblyopia: 62.5% (A) vs 61.1% (B); strabismus P = .03	Earlier surgery reduces strabismus; amblyopia rates comparable	Retrospective; small sample size; non-randomized
Lin et al.	BCVA: 6-mo group better than 3-mo (0.81 vs 0.96; P=0.02)	BCVA by procedure (B worse, P=0.007); complications unrelated	A = 0.80, B = 1.02, C = 0.84 logMAR (P = 0.007)	Surgery at 6 months yields better vision; timing matters	Single-center; small sample; no stratification
Louison et al.	BCVA: 0.5 (uni), 0.1 (bi) logMAR	PCO: 60% (uni) vs 46.3% (bi), P = 0.019	BCVA uni: 0.5 [IQR 0.2–0.8]; bi: 0.1 [IQR 0.0–0.8]	Better vision in bilateral cases; PCO was most frequent complication	Retrospective; small sample; no control over surgical variability
Sand et al.	CDVA: median 0.5 logMAR	VAO in all eyes; secondary glaucoma incidence = 10%	2 surgeries for VAO; 10% glaucoma	Good vision achieved; VAO common; glaucoma rate 10%	Small sample; no control group; retrospective design
Chattannavar et al.	Mean BCVA: uni 1.00, bi 1.21 logMAR (p=0.012)	Myopic shift: −2.9 D (aphakes), −4.53 D (pseudophakes)	BCVA uni: 1.00±0.08; bi: 1.21±0.03; myopic shift p=0.016	Pseudophakia showed slightly better vision, more VAO; aphakes had more glaucoma	Short follow-up; limited long-term data; no randomization
Zhang et al.	BCVA < 0.22 logMAR predicted by timing, nystagmus	Nomogram, AUC 0.712, C-index 0.797	HR (IOL <31 mo): 3.70; No nystagmus: HR 11.2	Early surgery, IOL ≤31 mo, no nystagmus → better outcome	Single center; retrospective; internal validation only
Dave H et al.	Visual acuity (logMAR), adverse events	Medical cost differences	Sequential: 0.47 ± 0.76; Simultaneous: 0.44 ± 0.40 (P = 0.92); 21.9% cost saving	Comparable outcomes; simultaneous surgery more cost-effective	Small sample size; retrospective; no confounder adjustment
Hansen Møller et al.	Subjective visual function (CVAQC score)	Difficulties in daily activities	CVAQC median scores: uni 0.88, bi 0.80 (p = 0.027); visual predictors p = 0.024	Unilateral cases had better perceived function; academic tasks hardest	Cross-sectional; no baseline data; small sample; self-report bias

Source: the authors.

The initial surgery to remove bilateral congenital cataracts has been proven to optimize long term lifespan results but comes with increased chances of problems. Hailaiti et al. (2025) evidence indicates that early surgery reduces the possibility of amblyopia but induces glaucoma and VAO. According to Zhang and his colleagues (2024), the early surgery is recommended, particularly in the case when nystagmus is absent, because of its indications of the higher level of visual acuity. Several studies show similar visual results on aphakia and pseudophakia although pseudophakia causes more inflammation. Though secondary problems are frequent, like VAO and glaucoma, still the positive visual outcomes are not canceled. In general, early intervention is efficient, yet the timing and careful subsequent monitoring are essential on an individual basis. (Hailaiti et al., 2025; Zhang et al., 2024; Singh et al., 2022; Long et al., 2006; Vasavada et al., 2018; Chak et al., 2006; Oshika et al., 2024; Kuhli-Hattenbach et al., 2017; Lin et al., 2017; Louison et al., 2019; Sand et al., 2021; Chattannavar et al., 2022; Dave et al., 2010; Hansen et al., 2020; Eckstein et al., 1999; Vasavada, 2001; Raina, 2002; Mullner, 2003). Hailaiti et al. (2025) analyzed 28 studies (2,167 children) and found a 62% pooled amblyopia prevalence post-cataract surgery. Early surgery (≤8 weeks unilateral/≤12 weeks bilateral) reduced amblyopia risk (53% vs. 79%, $P < 0.001$) but increased glaucoma (26% vs. 6%) and VAO (31% vs. 13%). Unilateral cataracts had higher amblyopia rates than bilateral (68% vs. 36%, $P = 0.003$).

IOL timing showed no significant effect ($P = 0.096$). The study concludes that early intervention optimizes vision despite higher complications, while prolonged amblyopia therapy (>6 years) offers limited benefit. Heterogeneity ($I^2 = 91.7\%$) and observational data limit certainty. Zhang et al. (2024) developed a prognostic model for 194 children with bilateral congenital cataracts, predicting long-term BCVA <0.22 LogMAR. Key predictors included cataract extraction before 6 months (HR 1.80, 95% CI: 0.92–3.70), IOL implantation before 31 months (HR 3.70, 95% CI: 1.77–7.80), and absence of nystagmus (HR 11.20, 95% CI: 3.96–31.80). The model showed moderate discrimination (AUC 0.712, C-index 0.797) and was visualized via nomogram. The study concludes that early intervention and nystagmus status significantly influence visual outcomes, aiding clinical decision-making. Limitations include retrospective design and lack of multicenter validation. Singh et al. (2022) reviewed 3 RCTs (79 children) comparing surgical approaches for bilateral congenital cataracts. At 5 years, visual acuity showed no significant difference between pseudophakia (mean 0.50 logMAR) and aphakia (0.59 logMAR; MD -0.09, 95% CI -0.24 to 0.06). VAO (RR 1.29) and glaucoma (RR 0.86) risks were comparable, but pseudophakic eyes had higher inflammatory sequelae (27.6% vs. 8%, $P=0.004$).

The review concludes no technique is superior, emphasizing the need for larger RCTs to assess timing, IOL age, and complications. Evidence certainty was very low due to bias and imprecision. Long et al. (2006) conducted a systematic review of RCTs evaluating surgical interventions in children with bilateral congenital cataracts. In Eckstein's trial (1999), lensectomy achieved better visual acuity than lens aspiration by 0.3 logMar ($P < 0.007$), with posterior capsule opacification occurring in 66% of aspiration eyes versus 2% of lensectomy eyes. Vasavada (2001) reported better low contrast acuity with anterior vitrectomy ($P = 0.02$). Raina (2002) showed fewer VAOs with optic capture. Mullner (2003) noted 72% achieved 20/25 or better. The review concludes both techniques are effective, but complications vary. Further trials are needed to guide practice. Vasavada et al. (2018) conducted a randomized clinical trial comparing primary aphakia and pseudophakia in 60 children (≤2 years) with bilateral congenital cataracts. At 5-year follow-up, mean visual acuity was 0.59 ± 0.33 (aphakia) and 0.5 ± 0.23 logMAR (pseudophakia), $P = .79$. Glaucoma occurred in 16% (aphakia) and 13.8% (pseudophakia), $P = .82$. Posterior synechiae were significantly higher in the pseudophakic group (27.6% vs 8%, $P = .004$).

Visual axis obscuration requiring surgery was similar (8% vs 10.3%, $P = .76$). Pseudophakia offered earlier visual rehabilitation but showed more inflammation. Overall complication rates were similar, suggesting both approaches are viable with distinct trade-offs. Chak et al. (2006) analyzed long-term visual outcomes in 122 children from the UK Congenital Cataract Study, with a follow-up ≥6 years post-surgery. Median visual acuity was 6/18 (bilateral) and 6/60 (unilateral). Better acuity correlated with early surgery (OR 0.98/month; 95% CI: 0.94–0.99) and good occlusion compliance. In unilateral cases, poor compliance increased odds of worse vision (OR 7.92; 95% CI: 1.68–37.26). Postoperative complications and comorbidities worsened bilateral outcomes. The study supports early intervention and emphasizes the role of compliance in long-term success, particularly for unilateral cases. Oshika et al. (2024) conducted a retrospective review of 216 eyes from 121 infants who underwent congenital cataract surgery within the first six months of life across 11 centers in Japan. Earlier surgery—before 10 weeks for bilateral and 6 weeks for unilateral cases—yielded significantly better long-term visual acuity. Visual axis opacification was more common with early surgery. Pseudophakia led to better outcomes than aphakia and was associated with lower glaucoma risk. Regression analysis confirmed laterality, lens status, comorbidities, and glaucoma development as predictors of visual acuity. The study supports early intervention and highlights the safety of modern IOL techniques. Kuhli-Hattenbach et al. (2017) retrospectively assessed visual and clinical outcomes in 26 infants (52 eyes) undergoing bilateral congenital cataract surgery within the first 12 months. Group A (≤10 weeks) and Group B (>10 weeks) had similar rates of mild or better amblyopia (62.5% vs 61.1%).

However, strabismus was significantly less common in the early surgery group ($P = .03$). Aphakic glaucoma and posterior capsule opacification were more frequent in children operated on within 14–20 weeks. While timing of surgery did not affect amblyopia rates, early intervention reduced strabismus but increased risk of complications, emphasizing the need for vigilant follow-up. Lin et al. (2017) conducted a randomized controlled trial of 57 infants (114 eyes) with congenital cataracts, comparing outcomes of surgery at 3 vs 6 months using three surgical approaches. After ~4 years, BCVA was significantly better in the 6-month group (0.81 ± 0.28) than in the 3-month group (0.96 ± 0.30), $P = 0.02$. Surgery B (I/A + PCCC) resulted in the poorest BCVA (1.02), $P = 0.007$. Complication rates did not significantly affect final vision. Findings suggest surgery at 6 months may be safer and more effective for visual prognosis, provided postoperative monitoring and intervention are rigorous. Louison et al. (2019) reviewed 56 congenital cataract surgeries in 37 infants (26.8% unilateral, 73.2%

bilateral) at Dijon University Hospital between 2005–2016. Median age at surgery was 1.0 years for unilateral and 2.7 years for bilateral cases. At final follow-up (median 2.0 years), BCVA was significantly better in bilateral (0.1 logMAR) than unilateral (0.5 logMAR) cases. Posterior capsule opacification was the most frequent complication, affecting 60.0% of unilateral and 46.3% of bilateral eyes (P = 0.019).

The study concludes congenital cataract surgery is effective when coupled with consistent amblyopia therapy. Visual prognosis was more favorable in bilateral cases. Sand et al. (2021) evaluated 15 infants (30 eyes) who underwent bilateral congenital cataract surgery with primary IOL implantation before 12 weeks of age. Median age at surgery was 35 days, with a follow-up of 6.1 years. Visual outcomes were favorable, with a median corrected distance visual acuity of 0.5 logMAR (range: 0.04–1.2). All eyes developed visual axis opacification (VAO) requiring a median of two procedures. The incidence of secondary glaucoma at 5 years was 10%. Despite high VAO risk, early IOL implantation yielded acceptable visual outcomes without excess risk of glaucoma compared to older infants. Chattannavar et al. (2022) prospectively evaluated 97 infants (173 eyes) with infantile cataracts over 1 year. Median age at surgery was 18.7 weeks. Primary IOL implantation was performed in 29.5% of eyes. Mean BCVA at 1 year was 1.00±0.08 (unilateral) and 1.21±0.03 (bilateral) logMAR (p=0.012). Pseudophakes had better BCVA (1.09±0.05) compared to aphakes (1.24±0.04), but this difference was not significant after correction. Myopic shift was greater in pseudophakes (−4.53 D) than aphakes (−2.9 D, p=0.016). Glaucoma was more frequent in aphakes, while visual axis opacification was more common in pseudophakes. IOL use is a viable option when aphakic care is limited. Zhang et al. (2024) conducted a retrospective study of 194 children with bilateral congenital cataracts to identify predictors of long-term visual outcomes. A prognostic model was developed to predict BCVA < 0.22 logMAR after cataract extraction and IOL implantation.

Key predictors included cataract surgery before 6 months (HR 1.80), IOL implantation before 31 months (HR 3.70), and absence of nystagmus (HR 11.20). The model showed good performance (AUC 0.712, C-index 0.797). Early surgery and nystagmus absence were strongly associated with favorable outcomes. The model supports individualized surgical timing and provides a clinical tool for visual prognosis prediction. Dave et al. (2010) compared visual outcomes, adverse events, and healthcare costs between simultaneous and sequential bilateral cataract surgeries in infants ≤6 months. Among 27 infants, visual acuity outcomes were comparable (logMAR 0.44 vs 0.47; P = .92), with no significant differences in complication rates, including postoperative glaucoma. No cases of endophthalmitis were reported. Simultaneous surgery was associated with a 21.9% reduction in overall healthcare costs. Although promising, the study's small sample size limits definitive conclusions regarding relative safety. Findings support the cost efficiency and potential clinical equivalence of simultaneous surgery in this population. Hansen et al. (2020) examined long-term visual outcomes in 56 Danish children aged 7–18 years who underwent cataract surgery. Subjective visual function, measured using the Cardiff Visual Ability Questionnaire for Children, was significantly better in children with unilateral cataract compared to bilateral cases (median CVAQC score: 0.88 vs 0.80; p = 0.027). Better visual acuity and contrast sensitivity were associated with higher subjective function (p = 0.024). The most challenging tasks involved academic and social activities. The findings suggest that unilateral cases benefit from compensatory vision in the unaffected eye, but bilateral cases may face greater academic challenges long term.

CONCLUSION

Bilateral congenital cataract Early surgery is of significant benefit in respect to vision and neurodevelopment. Working during the first three months of life seems to offer optimum functions. The effectiveness has to be counterbalanced, though, by the increased risk of developing postoperative complications. The visual prognoses must be considered regarding the long-term ocular health in favor of the clinical decisions, and near follow-up would be necessary. Our evidence can help to translate to a timely intervention with the consideration of factors on the patient level, but better quality-controlled trials are necessary to perfect the protocols and enhance the care.

REFERENCES

Chak, M., Wade, A., & Rahi, J. S. (2006). Long-term visual acuity and its predictors after surgery for congenital cataract: Findings of the British Congenital Cataract Study. Investigative Ophthalmology & Visual Science, 47(10), 4262–4269. https://doi.org/10.1167/iovs.05-1160

Chattannavar, G., Badakere, A., Mohamed, A., & Kekunnaya, R. (2022). Visual outcomes and complications in infantile cataract surgery: a real-world scenario. BMJ Open Ophthalmology, 7(1), e000909. https://doi.org/10.1136/bmjophth-2022-000909

Dave, H., Phoenix, V., Becker, E. R., et al. (2010). Simultaneous vs sequential bilateral cataract surgery for infants with congenital cataracts: Visual outcomes, adverse events, and economic costs. Archives of Ophthalmology, 128(8), 1050–1054. https://doi.org/10.1001/archophthalmol.2010.136

Hailaiti, A., Yu, X., Yao, K., & Shentu, X. (2025). Postoperative amblyopia in children with congenital cataracts: A systematic review and meta-analysis. Italian Journal of Pediatrics, 51(1), 141

Hansen, M. M., Bach-Holm, D., & Kessel, L. (2020). Visual outcomes after surgery for childhood cataracts. Acta Ophthalmologica, 98(6), 579–584. https://doi.org/10.1111/aos.14403

Kuhli-Hattenbach, C., Fronius, M., & Kohnen, T. (2017). Impact of timing of surgery on outcome in children with bilateral congenital cataract. Der Ophthalmologe, 114(3), 252–258. https://doi.org/10.1007/s00347-016-0326-5

Kuhli-Hattenbach, C., Fronius, M., & Kohnen, T. (2025). Bilaterale kongenitale Katarakt: Klinische und funktionelle Ergebnisse in Abhängigkeit vom Operationszeitpunkt [Bilateral congenital cataracts: Clinical and functional outcomes depending on surgical timing]. Ophthalmologie, 122(6), 487–497.

Lambert, S. R., Cotsonis, G., & DuBois, L. (2020). Long-term effect of intraocular lens vs contact lens correction on visual acuity after cataract surgery during infancy. JAMA Ophthalmology, 138(5), 365–372.

Lin, H.-T., Long, E.-P., Chen, J.-J., Liu, Z.-Z., Lin, Z.-L., Cao, Q.-Z., Zhang, X.-Y., Wu, X.-H., Wang, Q.-W., Lin, D.-R., Li, X.-Y., Liu, J.-C., Luo, L.-X., Qu, B., Chen, W.-R., & Liu, Y.-Z. (2017). Timing and approaches in congenital cataract surgery: a four-year, two-layer randomized controlled trial. International Journal of Ophthalmology, 10(12), 1835–1843. https://doi.org/10.18240/ijo.2017.12.08

Long, V., Chen, S., & Hatt, S. (2006). Surgical interventions for bilateral congenital cataract. Cochrane Database of Systematic Reviews, 2006(3), CD003171. https://doi.org/10.1002/14651858.CD003171.pub2

Louison, S., Blanc, J., Pallot, C., Alassane, S., Praudel, A., Bron, A.-M., & Creuzot-Garcher, C. (2019). Visual outcomes and complications of congenital cataract surgery. Journal Français d'Ophtalmologie, 42(4), 368–374. https://doi.org/10.1016/j.jfo.2018.10.007

Management of Bilateral Congenital and Juvenile Cataracts in a Low-Income Country. (2024). Children, 11(9), 1064.

Oshika, T., Nishina, S., Unoki, N., Miyagi, M., Nomura, K., Mori, T., Matsuki, N., Endo, T., Kurosaka, D., Negishi, K., Yoshida, S., & Nagamoto, T. (2024). Ten-year outcomes of congenital cataract surgery performed within the first six months of life. Journal of Cataract and Refractive Surgery, 50(7), 707–712. https://doi.org/10.1097/j.jcrs.0000000000001449

Sand, M. K., Cholidis, S., Rimstad, K., Krekling, E. D., Kristianslund, O., & Drolsum, L. (2021). Long-term outcome of primary intraocular lens implantation in bilateral congenital cataract in infants with a median age of 35 days at surgery: a case series. BMJ Open Ophthalmology, 6(1), e000705. https://doi.org/10.1136/bmjophth-2020-000705

Singh, R., Barker, L., Chen, S. I., Shah, A., Long, V., & Dahlmann-Noor, A. (2022). Surgical interventions for bilateral congenital cataract in children aged two years and under. Cochrane Database of Systematic Reviews, 9, CD003171. https://doi.org/10.1002/14651858.CD003171.pub3

StatPearls. (2025). Pediatric cataract. NCBI Bookshelf.

Vasavada, A. R., Vasavada, V., Shah, S. K., Trivedi, R. H., Rawat, F., & Koul, A. (2018). Five-year postoperative outcomes of bilateral aphakia and pseudophakia in children up to 2 years of age: A randomized clinical trial. American Journal of Ophthalmology, 193, 33–44. https://doi.org/10.1016/j.ajo.2018.06.007

Zhang, L., Zhao, C., He, M., Wu, T., Hao, Z., Zheng, C., Ma, J., & Zhou, J. (2024). Development of a prognostic model for predicting long-term visual acuity after cataract surgery in children with bilateral congenital cataracts: A single centre retrospective, observational study. BMC Ophthalmology, 24(1), 466.

Zhang, S., Wang, J., Li, Y., et al. (2019). The role of primary intraocular lens implantation in the risk of secondary glaucoma following congenital cataract surgery: A systematic review and meta-analysis. PLoS ONE, 14(4), e0214684.