Sequential correction of blepharophimosis syndrome: comparison of anatomical outcomes for surgery before and after 24 months of age

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PURPOSE To evaluate the safety and morphometric outcomes of early sequential surgical correction in pediatric patients with blepharophimosis-ptosis–epicanthus inversus syndrome (BPES) with significant functional impairment, comparing patients under and over 24 months of age.

METHODS The medical records of consecutive BPES patients undergoing two-stage treatment of Y-V epicanthoplasty followed by silicone frontalis suspension from 2019 to 2021 were retrospectively analyzed. Primary outcomes included morphometric parameters: ratio of inner intercanthal distance (IICD) to horizontal palpebral fissure length (HPFL), margin reflex distance-1 (MRD1), and vertical palpebral fissure length (VPFL). Secondary outcomes were visual axis clearance, compensatory posture resolution, and complications. Statistical analysis employed repeated measures ANOVA with Bonferroni correction.

RESULTS A total of 20 patients were included. Mean age at surgery was 43.4 ± 32.4 months (range, 6-120), with 11 patients (55%) under 24 months. At 6 months' follow-up, all morphometric parameters demonstrated significant improvement ($P < 0.001$): IICD/HPFL ratio decreased from 1.82 ± 0.23 to 1.13 ± 0.08; VPFL increased from 3.92 ± 0.71 mm to 8.22 ± 0.44 mm; and MRD1 improved from 0.45 ± 0.91 mm to 4.17 ± 0.40 mm. Visual axis clearance and resolution of compensatory chin-up posture were achieved in 100% of cases; surgical success (IICD/HPFL <1.3), in 95% of patients (19/20). Age-stratified analysis revealed no significant differences in outcomes between cohorts ($P > 0.05$). Grade I complications occurred in 5 patients (25%) and resolved conservatively.

CONCLUSIONS In select infants with severe BPES, early two-stage sequential correction can achieve visual axis clearance and anatomical outcomes comparable to those achieved in older children. (J AAPOS 2026;30:104852)

Blepharophimosis-ptosis–epicanthus inversus syndrome (BPES) is a rare autosomal dominant congenital disorder characterized by narrowing of the horizontal palpebral fissure, severe ptosis, epicanthus inversus, and telecanthus. It occurs in approximately 1 in 50,000 live births.[1]

Conventional surgical protocols generally recommend delaying intervention until children reach 3-5 years of age, allowing adequate tissue maturation while reducing the potential for growth-related surgical complications.[2] On the other hand, severe ptosis is a risk factor for deprivation amblyopia,[3] although the risk for ptotic eyes is higher in unilateral than bilateral cases. Many children with BPES need to adopt a marked compensatory chin-up head posture to clear the visual axis. Prolonged abnormal head positioning may cause cervical spine complications or hamper gross motor development. Early intervention may confer neuroplasticity benefits when severe ptosis significantly occludes the visual axis during critical periods of visual development,[4-6] because deprivation amblyopia can develop quickly in infancy.[7-9] Thus, marked compensatory head posturing and amblyopia risk may be indications for earlier anatomical correction in severely affected cases. Surgical intervention benefits in children younger than 24 months must, on the other hand, be weighed against possible anesthesia-related risks. Although recent studies suggest minimal neurodevelopmental impact from single, brief anesthetic exposures,[10,11] the safety profile of two separate exposures needed for staged BPES repair remains incompletely characterized.[12]

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Surgical approaches to BPES range from single-stage comprehensive repair to staged procedures. A staged approach that comprises initial medial canthoplasty followed by subsequent ptosis repair may enhance tissue healing and improve anatomical precision.[13,14] The purpose of this study was to assess morphometric outcomes and safety profiles following early two-stage surgical correction in consecutive BPES patients, comparing those younger than 24 months with older children. We hypothesized that carefully selected infants would demonstrate outcomes equivalent to those in older children, without increased complication rates.

Subjects and methods

The medical records of pediatric BPES patients who underwent two-stage surgical correction at Gaziantep University Hospital, Gaziantep, Turkey, from January 2019 through March 2021 were analyzed retrospectively. Approval was obtained from the Gaziantep University Clinical Research Ethics Committee. All procedures were conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants' guardians for surgical procedures, study participation, and publication of clinical images.

Patients with clinically confirmed BPES, with a complete phenotype, were included: severe ptosis (MRD1 ≤1 mm); poor levator function (measured excursion ≤4 mm in cooperative patients, or clinical assessment indicating equivalent dysfunction in preverbal patients); severe visual axis compromise, with documented functional impairment (complete obstruction [MRD1 ≤0 mm] or sustained compensatory chin-up posture ≥20°)[15]; and marked telecanthus, that is, ratio of inner intercanthal distance (IICD) to horizontal palpebral fissure length (HPFL) >1.5. Minimum follow-up was 6 months. Patients with syndromic associations, previous periocular surgery, incomplete documentation, contraindications to general anesthesia, and parental inability to comply with protocols were excluded.

Preoperative assessment

Standardized evaluation included high-resolution digital photography under controlled lighting. Quantitative measurements were performed by two independent pediatric ophthalmologists (ICC = 0.89; 95% CI, 0.74-0.96). Morphometric parameters included vertical palpebral fissure length (VPFL) at midpupil, MRD1 (from pupillary light reflex to upper lid margin), horizontal palpebral fissure length (HPFL), inner intercanthal distance (IICD), and ratio of IICD to HPFL (telecanthus quantification).

Levator function was assessed in patients ≥24 months of age as measurement of standard levator excursion from maximum downgaze to maximum upgaze with frontalis fixation. In preverbal children (<24 months), poor levator function was determined through convergent clinical indicators (severe ptosis, absent lid crease, minimal passive excursion) and confirmed intraoperatively by direct inspection of the dysgenetic muscle, consistent with established validation criteria.[16,17]

Age-appropriate protocols were used to evaluate visual function, including fixation pattern evaluation for infants <12 months of age, preferential looking assessment (Teller Acuity Cards) for patients aged 12–24 months, and the Cardiff Acuity Test for children ≥36 months when cooperation permitted.

Surgical technique

All procedures were performed by a single experienced oculoplastic surgeon (SA), with the patient under general anesthesia. Total anesthesia time was recorded for both stage 1 (Y-V epicanthoplasty) and stage 2 (silicone frontalis suspension).

In stage 1, horizontal fissure narrowing is addressed through Y-V plasty, with medial canthal tendon repositioning (Figure 1A-B). A Y-shaped incision (60° vectors) facilitates medial canthal tendon dissection, shortening, and anterior lacrimal crest fixation (4-0 polypropylene sutures). V-advancement closure employed 6-0 polyglactin 910 absorbable sutures. Stage 2 is performed 4-8 weeks later. In this procedure, upper lid crease incisions permit tarsal plate dissection with the 1.0 mm diameter silicone rod (Visitec Inc, Sarasota, FL) three-point fixation (6-0 polypropylene). A pentagonal Fox configuration[18] was achieved via suprabrow and central forehead incisions. Intraoperative tension targeted MRD1 ≥4 mm. Wound closure employed 6-0 polyglactin 910 absorbable sutures.

Postoperative management included topical antibiotic-steroid combination (prednisolone acetate 1% and tobramycin 0.3%) four times daily for 2 weeks, aggressive ocular lubrication, and oral analgesics as needed.

Outcome assessment

The primary endpoints were morphometric parameter changes, IICD/HPFL ratio reduction to <1.3 (surgical success threshold), and a clear visual axis. Secondary endpoints were visual function assessment, compensatory posture resolution, complications (grade I: minor, with conservative management; grade II: requiring additional procedures; grade III: permanent impairment), and lacrimal function via fluorescein dye disappearance testing. Evaluations occurred at 1 week, 1 month, and 6 months postoperatively with photographic documentation.

Statistical analysis

Data analysis employed SPSS version 28.0 (IBM Corporation, Armonk, NY). Repeated measures analysis of variance assessed temporal changes with Bonferroni correction. Effect sizes were calculated using Cohen's d with 95% confidence intervals. Independent *t* tests compared age-stratified outcomes (<24 vs ≥24 months), with Mann-Whitney *U* tests for nonparametric distributions. A *P* value of <0.05 was considered statistically significant.

Results

During the study period, 27 BPES patients were evaluated at our institution. Seven patients did not undergo two-stage surgical correction: 4 with milder phenotypes (MRD1 >1 mm, absent compensatory posturing) were managed conservatively; 2 families elected delayed surgery; and 1 patient presented after enrollment cutoff. A total of 20 patients (13 males) met inclusion criteria. Mean age at surgery was 43.4 ± 32.4 months (range, 6-120; median,

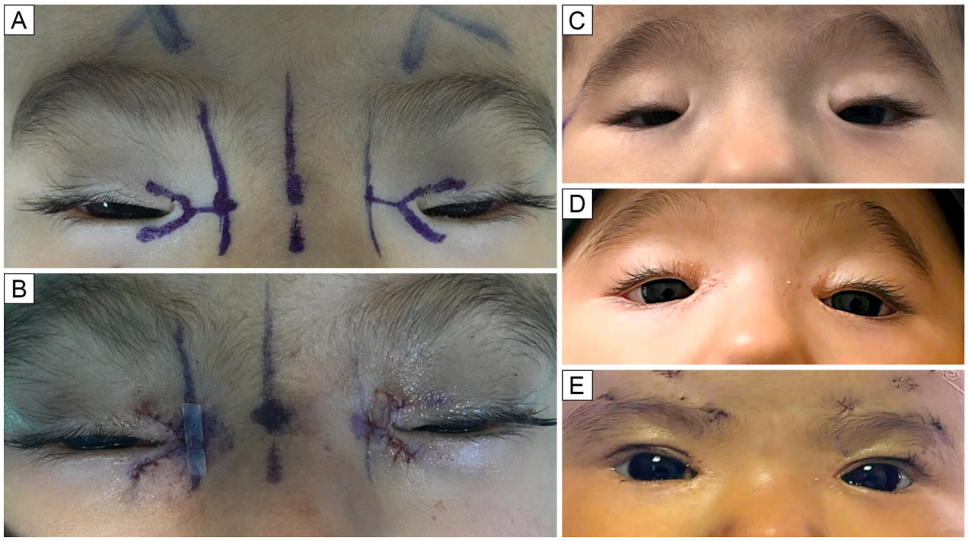

FIG 1. Y-V epicanthoplasty technique and sequential surgical outcomes in BPES patients. A, Preoperative surgical markings in a 13-month-old patient showing Y-configuration for medial canthal reconstruction. B, Immediate postoperative appearance with V-shaped advancement flaps. C, Preoperative appearance in 12-month-old patient showing characteristic BPES features. D, One-month post-canthoplasty. E, Six months following frontalis suspension showing final outcome.

36). Eleven patients (55%) were under 24 months of age (Table 1).

Baseline characteristics

Mean preoperative levator function in cooperative patients (n = 9) was 3.2 ± 0.8 mm; all preverbal patients (n = 11) demonstrated clinical indicators of poor levator function, which was confirmed intraoperatively. Eighteen patients (90%) had compensatory chin-up posture, and all patients had severely compromised visual axis, with MRD assessment with the head held straight showing complete obstruction (MRD1 ≤0 mm) in 14 patients (70%) and severe ptosis with functional impairment (MRD1 0–1 mm,

Table 1. Baseline demographics and clinical characteristics (N = 20)

Characteristic	Value
Demographics	
Sex, no. (%)	
Male	13 (65)
Female	7 (35)
Age, months, at stage 1 surgery, mean ± SD (range) [median]	43.4 ± 32.4 (6-120) [36]
Age distribution, no. (%)	
0-12 months	4 (20)
12-24 months	7 (35)
>24 months	9 (45)
Preoperative levator function assessment	
Formal measurement, mm, (patients ≥24 months [n = 9]), mean ± SD (range)	3.2 ± 0.8 (2-4)
Clinical assessment (patients <24 months [n = 11])	Poor function[a] (100%)
Visual axis compromise and functional impairment	
Severe visual axis compromise (all patients), no. (%)	20 (100)
Complete obstruction (MRD1 ≤0 mm)	14 (70)
Severe ptosis with functional impairment (MRD1 0–1 mm)[b]	6 (30)
Compensatory chin-up head posture (≥20°)	18 (90)
Refractive status	
Spherical equivalent, D, mean (range)	+2.50 ± 1.25 (+0.50 to +5.00)
Astigmatism (n = 16), D,[c] mean (range)	1.65 ± 0.88 (0.50 to 3.25)
With-the-rule, no. (%)	13 (81)

BPES, blepharophimosis-ptosis-epicanthus inversus syndrome *D*, diopters; *MRD1*, margin reflex distance-1; *SD*, standard deviation.
[a]Clinical assessment based on convergent indicators: severe ptosis (MRD1 ≤1mm), absent/high lid crease, minimal passive excursion, BPES phenotype. Confirmed intraoperatively by levator muscle anatomical characteristics.
[b]Functional impairment documented by sustained compensatory chin-up posture ≥20°.
[c]Cycloplegic refraction data available for 16/20 patients (80%); 4 patients had incomplete data due to age-related cooperation limitations.

functional impairment documented by compensatory posturing) in 6 patients (30%).

Mean refractive error was +2.50 ± 1.25 D spherical equivalent. Mean astigmatism was 1.65 ± 0.88 D (range, 0.50–3.25 D) in 16 patients (80%), predominantly with-the-rule orientation (81%). Mean durations of anesthesia were 42 ± 8 minutes (stage 1) and 38 ± 7 minutes (stage 2), for cumulative mean exposure 80 ± 12 minutes.

Primary outcomes

At 6-month follow-up, all primary measures showed significant improvement, with large effect sizes (Table 2; Figure 1C-E): IICD/HPFL ratio, 1.82 ± 0.23 to 1.13 ± 0.08 ($P < 0.001$; Cohen's $d = 4.2$; 95% CI, 3.1-5.3); VPFL, 3.92 ± 0.71 mm to 8.22 ± 0.44 mm ($P < 0.001$; Cohen's $d = 7.3$; 95% CI, 5.8-8.8); MRD1, 0.45 ± 0.91 mm to 4.17 ± 0.40 mm ($P < 0.001$; Cohen's $d = 5.1$; 95% CI, 3.9-6.3). Surgical success (IICD/HPFL <1.3) was achieved in 19 of 20 patients (95%); 1 patient had an IICD/HPFL ratio of 1.31.

No statistically significant differences existed between <24-month (n = 11) and ≥24-month (n = 9) cohorts (Table 3). IICD/HPFL improvement: 0.68 ± 0.18 vs 0.69 ± 0.20 ($P = 0.90$); MRD1: 3.72 ± 0.52 mm vs 3.71 ± 0.55 mm ($P = 0.96$); VPFL: 4.32 ± 0.35 mm vs 4.27 ± 0.38 mm ($P = 0.75$).

In terms of secondary outcomes, clearing of the visual axis was achieved in all cases; resolution of compensatory posture, in 18 of 18. Limited visual function assessment was available in 18 of the 20 patients (90%). Of the 9 patients ≥24 months of age, 8 demonstrated central, steady, maintained fixation bilaterally and 1 patient was uncooperative for assessment. Formal visual acuity testing (Cardiff Acuity Test) was achievable in 5 patients ≥36 months, demonstrating mean visual acuity of 0.38 ± 0.12 logMAR. In the 7 patients aged 12–24 months, preferential looking assessment (Teller Acuity Cards) showed age-appropriate responses in 6 patients, with 1 patient demonstrating delayed responses requiring continued monitoring. For the 4 patients <12 months of age, fixation pattern assessment demonstrated central fixation in 3 patients; the remaining patient (<8 months) had inconclusive results due to limited cooperation. Lacrimal function remained normal in 19 of the 20 patients (95%), with 1 patient demonstrating transient delayed clearance resolving spontaneously by 3 months.

Complications

Grade I complications occurred in 5 patients (25%), 1 with granuloma, 2 with exposure keratitis, and 2 with lateral ectropion. All resolved with conservative (non-surgical) management. Age-stratified complication rates were 3 of 11 in children <24 months (27%) and 2 of 9 in children ≥24 months (22% [$P = 0.85$]). There were no anesthetic complications.

Discussion

This study demonstrates that early sequential BPES correction is technically feasible in carefully selected patients <24 months of age, with morphometric outcomes and safety profiles comparable to those reported for older pediatric cohorts.

Prior to surgery, 90% of our patients had adopted a chin-up head posture. This indicates functional impairment in primary gaze and shows that ptosis was disrupting normal visual behavior. Chronic abnormal head positioning carries known risks of cervical spine complications and developmental constraints have been documented.[15] After surgery, every patient had normal head positioning.

The cumulative anesthetic burden of staged surgery warrants careful consideration. Our patients received mean total anesthesia time of 80 ± 12 minutes across two exposures. Recent large-scale studies (MASK study, GAS study) suggest minimal neurodevelopmental sequelae from single brief exposures in children under 3 years of age[10-12]; however, the specific safety profile of multiple staged exposures in infants remains incompletely characterized. This represents a significant concern that must be weighed against deprivation amblyopia risk on a case-by-case basis. Institutions must have robust anesthesia safety protocols and families must fully understand cumulative exposure risks before proceeding with staged repair in very young children.

Table 2. Temporal analysis of morphometric outcomes[a]

Parameter	Preop	Postop 1 week	Postop 1 month	Postop 6 months	*P* value
HPFL right, mm	18.95 ± 1.98	24.50 ± 1.46	24.40 ± 1.53	24.40 ± 1.53	<0.001
HPFL left, mm	18.95 ± 1.98	24.50 ± 1.57	24.40 ± 1.53	24.40 ± 1.53	<0.001
IICD, mm	34.20 ± 2.14	27.60 ± 1.53	27.60 ± 1.53	27.60 ± 1.53	<0.001
IICD/HPFL ratio	1.82 ± 0.23	1.12 ± 0.14	1.13 ± 0.08	1.13 ± 0.08	<0.001
VPFL right, mm	3.92 ± 0.71	8.25 ± 0.63	8.27 ± 0.44	8.22 ± 0.44	<0.001
VPFL left, mm	3.92 ± 0.71	8.25 ± 0.63	8.27 ± 0.44	8.22 ± 0.44	<0.001
MRD1 right, mm	0.45 ± 0.91	4.20 ± 0.44	4.22 ± 0.34	4.17 ± 0.40	<0.001
MRD1 left, mm	0.45 ± 0.91	4.20 ± 0.44	4.22 ± 0.34	4.17 ± 0.40	<0.001

HPFL, horizontal palpebral fissure length; *IICD*, inner intercanthal distance; *MRD1*, margin-reflex distance-1; *VPFL*, vertical palpebral fissure length.
[a]Data shown as mean ± SD. All comparisons used repeated measures ANOVA with Bonferroni correction.

Table 3. Age-stratified comparison of surgical improvements

Parameter improvement[a]	Age <24 months (n = 11)	Age ≥24 months (n = 9)	Mean difference (95% CI)	*P* value[b]
IICD/HPFL ratio reduction	0.68 ± 0.18	0.69 ± 0.20	0.01 (−0.15 to 0.17)	0.90
MRD1 increase, mm	3.72 ± 0.52	3.71 ± 0.55	−0.01 (−0.48 to 0.46)	0.96
VPFL increase, mm	4.32 ± 0.35	4.27 ± 0.38	−0.05 (−0.37 to 0.27)	0.75

HPFL, horizontal palpebral fissure length; *IICD*, inner intercanthal distance; *MRD1*, margin-reflex distance-1; *VPFL*, vertical palpebral fissure length.
[a]Improvement calculated from preoperative to 6-month postoperative measurements.
[b]Independent *t* test.

Our surgical success rate was 95% (IICD/HPFL <1.3). This compares well with published data, including the 78% rate Wu and colleagues[19] reported in patients under 5 years of age. We used a staged approach because it satisfactorily manages the anatomical complexity of BPES. We typically chose silicone rods rather than autologous fascia lata for several reasons. Fascia lata does provide better long-term durability; however, harvesting it from infants <24 months of age causes more morbidity. By using silicone suspension, we prioritized immediate elimination of amblyogenic factors, accepting that some patients might later need revision or conversion to fascia lata. Still, the technical challenges in very young children favor delayed intervention when the BPES presents no urgent functional need. Fascia harvest becomes safer and more practical in children more than 3 years of age.[20]

In our series, outcomes were similar across age groups. This result challenges the traditional view that surgery should wait for tissue maturation and suggests that younger tissue responds well to staged reconstruction when appropriate expertise is available. The chief drawback is the requirement of two anesthetic exposures. This raises concerns about cumulative anesthetic burden, as discussed earlier.

Based on these findings, we believe that early intervention (under 24 months) for BPES may be appropriate when clear indications exist, including complete axis obstruction (MRD1 ≤0 mm) without consistent compensatory behaviors to achieve clearance of the visual axis, or documented amblyopia. Delayed intervention may be a better choice when the child achieves partial visual axis clearance through compensatory mechanisms and has stable visual development, or when there are contraindications to early anesthesia. Patients who might qualify for single-stage fascia lata repair later may also be better served by delay. Our study proves the feasibility of an early staged approach but not its superiority.

The lack of comprehensive, quantitative visual acuity data constitutes a significant limitation of our study. Although amblyopia prevention is a primary justification for early intervention,[2] our study provides limited data on visual acuity outcomes due to preverbal assessment challenges and brief follow-up. Clearance of the visual axis was achieved in all cases, but we cannot conclude that early intervention resulted in fewer cases of amblyopia than delayed approaches. Future studies should include detailed visual acuity assessment and extended follow-up through school age. Other limitations are the lack of a control group, the relatively brief follow-up period, and difficulty assessing infant visual acuity. These prevent us from drawing any conclusions about amblyopia prevention.

In addition, our study lacks documentation of refractive error, and thus we cannot comment on whether early intervention has any advantages over later intervention with regard to refractive outcomes, such as astigmatism. Our rationale for not performing postoperative cycloplegic refraction at the 6-month follow-up was that emmetropization may still be occurring in the age groups we studied[21]; however, it should be emphasized that regular assessment and appropriate treatment of refractive error is an integral part of the management of BPES.

Another concern worth considering is that postoperative complications could potentially cause amblyopia. Two of our patients needed intensive lubrication for exposure keratitis. If prolonged, this could theoretically induce amblyopia. In a developing visual system, iatrogenic amblyopia from surgical complications might pose risks worth considering carefully, especially when the child's compensatory mechanisms were maintaining adequate function before surgery.

The 6-month follow-up is insufficient for long-term cosmetic evaluation. Operating on immature structures may theoretically lead to different revision rates at skeletal maturity compared with delayed surgery. Without longitudinal comparison to delayed cohorts, we cannot determine cosmetic advantages or equivalence. Furthermore, single-center design and age-stratified levator assessment limit the generalizability of our results. Nevertheless, in our study cohort, early intervention proved a reasonable option when visual function was compromised by BPES. On the other hand, delayed intervention has the advantages of greater surgical ease and avoidance of early anesthetic exposure. Determining optimal timing for surgery will require long-term, multicenter comparative studies.

Literature search

We searched PubMed and EMBASE databases from 1980 to 2022 using the following search terms, combined using Boolean operators: *blepharophimosis syndrome*, *BPES*, *early surgical intervention*, *pediatric ptosis*, and *frontalis suspension*. Additional articles were located through manual reference

review. Foreign-language articles without English-language abstracts were excluded.

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