OPEN ACCESS

DOI:10.59736/IJP.23.04.995

ORIGINAL ARTICLE

Evaluation of treatment modalities for congenital ptosis: indications, techniques, and long-term outcomes

Afzal Qadir[1], Naz Ullah[1*], Aleena Khan[2], Muhammad Ashraf[1] and Noor ul Hussain[1]

[1] Department of Pediatric Ophthalmology Hayatabad Medical Complex Peshawar Pakistan, [2] Fellow Orbit and Oculoplastic, Hayatabad Medical Complex Peshawar Pakistan

ABSTRACT

Background: Congenital ptosis, characterized by drooping of the upper eyelid present at birth, can adversely affect visual development and facial appearance. Timely surgical correction is essential to prevent amblyopia, maintain a clear visual axis, and achieve satisfactory functional and cosmetic outcomes. Our objective is to evaluate the indications, surgical procedure, and results of different methods of surgery in congenital ptosis on long-term follow-up.

Methods: This Prospective observational study was carried out over a span of 4 years, January 2021 to December 2024), in Ophthalmology department, Hayatabad Medical Complex, Peshawar. This study included 38 patients aged 3 to 18 years with simple congenital ptosis. Preoperative assessment included the levator function, MRD1, the palpebral fissure height, Bell's phenomenon, and visual acuity. The patients underwent frontalis suspension, levator resection, and/or conjoint fascial sheath (CFS) sling according to levator function and ptosis degree. **Results:** In the preoperative period, the average MRD 1 was 0.7 ± 0.5 mm and it was significantly increased to 3.1 ± 0.6 mm postoperatively ($p < 0.001$). Frontalis suspension was carried out in 24 patients, levator resection in 15, and CFS suspension in 5. Overall, 86.4% of patients had eyelids (≤1 mm asymmetry), and the best results were found in the CFS group. Recurrence was observed in 9.1%, predominantly in the frontalis suspension group. Lagophthalmos was observed in 25% of subjects, with predominance of mild forms.

Conclusion: Conjoint fascial sheath suspension with or without levator advancement is a safe and effective, less morbid approximation to frontalis suspension in certain types of congenital ptosis, particularly in patients with fair to good levator function. It results in improved eyelid symmetry, less complications and better patient satisfaction.

Keywords: Congenital Ptosis, Conjoint Fascial Sheath, Frontalis Suspension, Levator Resection, Pediatric Oculoplasty

This article may be cited as: Qadir A, Ullah N, Khan A, Ashraf M, Hussain NU. Evaluation of treatment modalities for congenital ptosis: indications, techniques, and long-term outcomes. Int J Pathol 23(4):281-9. https://doi.org/10.59736/IJP.23.04.995

CORRESPONDING AUTHOR

Dr. Naz Ullah

Ophthalmology Department

Hayatabad Medical Complex Peshawar

Email: dr.nnaz40@gmail.com

Introduction

Congenital ptosis is a complex ocular disorder in which the upper eyelid is drooping from birth or early infancy, it can affect visual development and the patients' psychosocial health. While some mild cases may resolve themselves, surgical

intervention is frequently required to include the affected eye in vision development, reduce refractive error, and improve both symmetry and appearance (1). Frontalis suspension is performed in patients with severe levator dysfunction (usually defined as ≤4mm of levator excursion), whereas those with fair to good function may be considered for levator resection or Müller's muscle procedures (2).

Frontalis sling surgery significantly enhances MRD1, while levator resection primarily improves palpebral fissure height (PFH). The choice of surgical technique and materials is closely related to the risk of lagophthalmos and the cosmetic outcome. Examples include different operative patterns (fox pentagon vs double triangle), suture types (absorbable vs non-absorbable), and sling materials (silicone rod vs Gore-Tex or autogenous fascia lata) to optimize symmetry (3). A large retrospective cohort study of unilateral congenital blepharoptosis patients demonstrated that despite surgery, approximately 25.7% of patients had persistent amblyopia with the age at surgery, baseline amblyopia, strabismus, and degree of astigmatism serving as risk factors that prompted a proposed predictive risk score (AUC≈0.75) (4).

Additionally, new techniques are being reported: in children aged 3-7, conjoint fascial sheath (CFS) plus levator muscle suspension has produced cure rates of 78–90% with stable palpebral fissure height and few complications, maintaining more physiologic eyelid function and contour (5). A low long-term recurrence rate and positive aesthetic and functional effects are confirmed by analogous techniques in other series.

In addition to functional considerations: the psychosocial advantages of ptosis surgery have been a subject of recent interest. A cohort of Malaysian children and their parents showed a statistically significant improvement in children's social anxiety and health-related quality of life (HRQoL) after surgery, with significant correlation to improved MRD1 symmetry and decreased inter-eye difference (6).

Furthermore, the refractive results have been investigated over time: the postoperative astigmatism is significantly augmented in the eyes in which elevation of MRD1 ≥ 2.5mm is accomplished, whereas the spherical equivalents remain constant-that underlines the significance of preoperative counselling and the subsequent follow-up (7).

Based on levator function, severity, and patient-related criteria, the literature collectively highlights a variety of surgical procedures, including frontalis slings made of various materials, levator resection approaches, and CFS levator combination—for congenital ptosis, on a case-by-case basis (8). Aesthetic symmetry and psychological well-being are among the many indications for surgery for visual axis protection. Various modalities and risk factors, such as the persistence of amblyopia and induced astigmatism, affect long-term results; however, advancements in technology and predictive risk stratification are improving prescription specificity (9).

The aim of this article is to present an evidence-based overview and practical management algorithm for congenital ptosis tailored to clinicians and surgeons. By evaluating the available treatment options including clinical indications, surgical techniques, sling materials, and

long-term functional and psychosocial outcomes—this study seeks to support informed decision-making and improve both visual and cosmetic results in affected patients.

Methods

This was a prospective, observational study carried out at Ophthalmology Department, Hayatabad Medical Complex, Peshawar from January 2021 to December 2024. The center is a tertiary referral center for ophthalmological disorders in the region. Institutional Review Board approval was granted (reference # 1418) dated 28.12.2020 before the study was conducted and informed consent was obtained from all participants (or legal guardians in the case of minors). A total of 38 congenital ptosis patients who visited the study Centre and satisfied the inclusion requirements served as the study subjects. The study comprised patients with unilateral or bilateral simple congenital ptosis, aged 3 to 18 years, with levator palpebrae superioris (LPS) function of ≤12 mm. Individuals with acquired ptosis, syndromic conditions such as Marcus Gunn jaw-winking phenomenon or blepharophimosis syndrome, severe ocular surface disease or severely compromised Bell's phenomenon deemed unsafe for surgery, or incomplete data were excluded.

All subjects underwent comprehensive ophthalmological assessments that contained cycloplegic refraction and thorough evaluations of the eyelids. These assessments included margin reflex distance-1 (MRD1), palpebral fissure height (PFH), and levator function (in millimeters, determined by comparing downgaze and upgaze). Amblyopia was diagnosed if there was a disparity of two or more lines of vision between the eyes, or a vision of <6/9 in the worse-seeing eye. To rule out restrictive and/or neurogenic pathologies, subjects were observed for Bell's Phenomenon and eye movement. For younger children who could not cooperate sufficiently for a Snellen visual acuity determination, visual acuity testing was accomplished with age-appropriate resources, including the Lea symbols and Cardiff acuity cards, and fixation, central steady maintained (CSM) fixation, and occlusion aversion were all included as necessary. For uncooperative children's, levator function was assessed via observation, utilizing the eyelid movement provoked by fixation of the subject on a toy or bright target, while laterally stabilizing the forehead to minimize frontalis activity.

All surgical procedures were performed by two consultant oculoplastic surgeons, each with more than 10 years of experience. The decision for surgical intervention depended on the severity of the ptosis, effect on the visual axis, abnormal head position, and cosmetic deformity. According to the levator function and age of the child, the type of the surgical procedure was chosen. Overall, young children with underdeveloped levator muscles, especially those under 6 years, who needed consistent eyelid elevation without the need for intraoperative collaboration, received frontalis suspension more often than not. Conversely, in older, more cooperative children (usually, at least six years), who had moderate levator function and could allow for stepwise modification of the eyelid elevation position, levator resection became more routine. In the case of younger patients with good levator muscle excursion, suboptimal levator muscles, imprecisely detailed eyelid creases, and a need for a controlled eyelid position, concise fascial sheath (CFS) suspension was

employed.Levator-function impaired patients (<4 mm) were subjected to frontalis suspension according to silicon rod or autogenous fascia lata. Patients with fair levator function underwent levator resection. Conjoint fascial sheath suspension was performed in some cases of good levator function.

To minimize any potential selection bias, the decision to perform conjoint fascial sheath (CFS) suspension in these patients with good levator function was based on predefined clinical considerations rather than surgeon preference. In younger children who were less likely to cooperate with intraoperative eyelid height adjustment, CFS suspension was considered preferable due to its more predictable postoperative eyelid position. In all cases, the selection was finalized following standardized counseling with the parents regarding the relative advantages and limitations of each surgical option.

The amount of levator resection, surgical plane, length of the procedure, and any intraoperative complications (such as bleeding or malposition eyelids) were all recorded. Following the procedure, patients received routine checkups during the first week, first month, sixth month, and one year. All outcome measures reported in this study were recorded at the 12-month follow-up visit. In cases of relapse, reoperation was considered and carried out after confirmation of functional or cosmetic failure at the 12-month follow-up visit. Postoperative MRD1, PFH, lagophthalmos, palpebral symmetry (lid symmetry), exposure keratopathy, and complications (infection, granuloma, sling exposure, recurrence) were the outcome measures. Relapse was defined as either patient dissatisfaction necessitating reoperation or a drop in MRD1 of 2 mm or more in comparison to the early postoperative value. A five-point Likert scale was used to gauge cosmetic satisfaction after a year.

IBM, SPSS V25.0 was used to analyze the data. Age, MRD1, PFH, and other variables with continuous values were defined as mean ± standard deviation. Frequency and percentage were used to list categorical data, including recurrence, complications, surgical technique, laterality, and gender. A p-value of ≤0.05 was considered significant.

Results

A total of 44 eyelids were affected in 38 patients. Unilateral ptosis was more common, observed in 32 (84.2%) patients, while bilateral involvement was seen in 6 (15.8%) patients. The mean age at presentation was 8.4 ± 3.6 years (range: 3–18 years). Of these, 27(71%) were males and 11(29%) were females. Demographic and baseline characteristics are summarized in Table 1.

Table 1. Demographic and Baseline Characteristics of the Patients

Variable	Value
Mean age (years)	8.4 ± 3.6
Mean duration of symptoms (years)	2.1 ± 1.4
Gender	
Male	27 (71%)
Female	11 (29%)
Laterality	
Unilateral	32 (84.2%)
Bilateral	6 (15.8%)
Unilateral – Right eye	18 (56.3%)
Unilateral – Left eye	14 (43.7%)
Family history of ptosis	
Yes	5 (11.4%)
No	39 (88.6%)
Preoperative amblyopia	
Yes	6 (13.6%)
No	38 (86.4%)

The mean preoperative MRD1 was 0.7 ± 0.5 mm. Levator function was poor in 21 patients

(47.7%), fair in 13 (29.5%), and good in 10 (22.7%). Palpebral fissure height averaged 5.2 ± 1.4 mm. Amblyopia was detected in 15 patients (34.1%), and astigmatism ≥1.0 D was found in 23 (52.3%). Bell's phenomenon was good in 36 (81.8%), fair in 6 (13.6%), and poor in 2 (4.5%). Table-2

Table 2. Preoperative Clinical Findings

Variable	Frequency	Percentage (%)
Mean Preoperative MRD1 (mm)	0.7 ± 0.5	—
Levator Function		
- Poor (<4 mm)	21	47.7
- Fair (5–7 mm)	13	29.5
- Good (8–12 mm)	10	22.7
Palpebral Fissure Height (mm)	5.2 ± 1.4	—
Amblyopia	15	34.1
Significant Astigmatism (≥1.0 D)	23	52.3
Bell's Phenomenon		
- Good	36	81.8
- Fair	6	13.6
- Poor	2	4.5

Patients with poor levator function (<4mm) underwent frontalis suspension 24(54.5%), 15 (34.1%) had levator resection, and 5 (11.4%) underwent conjoint fascial sheath suspension. Silicone rod was used in 18 frontalis sling cases, while autogenous fascia lata was used in 6. General anesthesia was administered in 38 (86.4%) patients, while 6 (13.6%) surgeries were done under local anesthesia. The mean operative time was 42 ± 9 minutes. In bilateral cases, both eyelids of the same patient were operated on, and the same surgical procedure was applied to each eyelid to maintain symmetry. Table-3

Table 3. Surgical Techniques

Variable	Frequency	Percentage (%)
Surgical Procedure		
Frontalis Suspension	24	54.5%
Levator Resection	15	34.1%
CFS Suspension	5	11.4%
Sling Material (Frontalis group)		
Silicone Rod	18	75%
Fascia Lata	6	25%
Type of Anaesthesia		
General	38	86.4%
Local	6	13.6%
Mean Operative Time (minutes)	42 ± 9	—

Data are presented per eyelid. Frontalis suspension was mainly performed for eyelids with poor levator function (<4 mm); however, in bilateral cases and selected eyelids with borderline function, the same procedure was applied to maintain

symmetry. Silicone rod was used in most cases, while fascia lata was reserved for older children. Levator resection and CFS suspension were performed in eyelids with fair to good levator function.

At one-year follow-up, the mean postoperative MRD1 increased significantly from baseline to **3.1 ± 0.6 mm** (**P < 0.001**). Similarly, the mean palpebral fissure height (PFH) improved significantly from 5.2 ± 1.4 mm preoperatively to 8.9 ± 1.2 mm postoperatively (P < 0.001), indicating effective elevation of the upper eyelid aperture following surgical intervention. Aesthetic eyelid symmetry (inter-lid difference ≤1 mm) was achieved in 38 eyelids (86.4%). Lagophthalmos was observed in 11 cases (25.0%), predominantly mild in severity. Exposure keratopathy occurred in 3 cases (6.8%) and resolved with conservative management. Postoperative wound infection developed in 2 cases (4.5%), and granuloma formation was noted in 1 case (2.3%). Recurrence occurred in 4 cases (9.1%) at one-year follow-up. Overall cosmetic satisfaction was high, with 37 patients (97%) reporting "satisfied" or "very satisfied" outcomes (Table 4).

Table 4. Postoperative Outcomes

Outcome	Value
Mean Postoperative MRD1 (mm)	3.1 ± 0.6
Eyelid Symmetry Achieved	38 (86.4%)
Lagophthalmos	11 (25%)
- Mild	8 (18.1%)
- Moderate	2 (4.5%)
- Severe	1 (2.2%)
Exposure Keratopathy	3 (6.8%)
Postoperative Wound Infection	2 (4.5%)
Granuloma Formation	1 (2.3%)
Recurrence	4 (9.1%)
Patient Satisfaction (Good–Excellent)	37 (97%)

[Postoperative outcomes—including MRD1, palpebral fissure height, lagophthalmos, and eyelid symmetry—were recorded for each eyelid individually. Intra-patient comparison revealed no significant difference in outcomes between the two eyelids of bilateral patients. Complications such as exposure keratopathy, infection, or recurrence were documented per eyelid, while patient-reported cosmetic satisfaction was assessed at the patient level.

Discussion

The predominance of male patients was noted in upto 71% of our study population, and more than two-thirds of cases (84.2%) were unilaterally affected. These findings are consistent with earlier research by Owji et al, who found similar correlations between laterality and gender (10).

At an average age of 8.4 years in our study, the presentation was late compared to trials conducted in higher-income countries, where earlier interventional techniques would be feasible. For example, in a similar group, Ghiam et al (11) reported a median age of 5.6 years. As a result, delayed presentation and limited access to specialized ophthalmic care may contribute to late diagnosis and treatment of congenital ptosis, potentially increasing the risk of amblyopia and other visual developmental abnormalities.

Additionally, 34.1% of our sample had amblyopia, and 52.3% had substantial astigmatism (≥1.0 D). These results were consistent with those of Evereklioglu et al (12), who found that 30–38% of children with congenital ptosis had amblyopia, and more than 50% had astigmatism. Ptosis is linked to refractive error (astigmatism) because the infant's cornea is continuously compressed by the eyelids.

A poor levator function (<4mm) was seen in 47.7% of cases and based on established

protocols, such cases were indicated for the frontalis suspension surgery. This type of patient stratification has been confirmed by Kasaee et al (13), who demonstrated the importance of levator function in the choice between frontalis suspension and levator resection.

Frontalis suspension was the most commonly performed procedure, carried out in 24 of 44 cases (54.5%), mostly in those with poor LPS function, with silicone rods used in 75% of these cases. This is consistent with the observations of Dallalzadeh et al (14), who supported the use of silicone rods given their adjustability and minimal morbidity. Although autogenous fascia lata provides better long-term stability, it was used in only a few patients due to the additional morbidity associated with graft harvesting and age-related limitations. In our study, 34.1% of participants underwent levator resection and 11.4% underwent CFS suspension, primarily in patients with fair to good levator function.

Liu et al (15) in his study have also shown good functional and cosmetic results with CFS suspension, mainly in younger children, which is in line with our study. According to standard pediatric surgical practice, general anesthesia was used in the majority of cases (86.4%) in our study, since it provides better control over uncooperative youngsters, reduces anxiety, and produces safer results.

Our encouraging functional and cosmetic results are evidenced by our postoperative outcomes. The MRD1 also increased significantly from 0.7 mm to 3.1 mm ($P < 0.001$), indicating the effectiveness of these procedures which was reported by many other studies (16,17). The achieved rate (86.4%) for eyelid symmetry in our results (interlid difference ≤1 mm) is also consistent with the results of other series (82–88%) (18).

Only 25% of patients had lagophthalmos, and it was mild in most cases with this incidence equal to the rate reported by Thera et al (19). Nevertheless, only 6.8% experienced exposure keratopathy that was treatable with standard methods; this finding suggests that appropriate perioperative eye coverage and monitoring were applied.

The recurrence rate in our series was 9.1% (it either represented <2-mm drop from MRD1 or need of reoperation). This is within the range of what have been considered acceptable rates (8–15%) in a study by Shome et al (20). The recurrence in our study may be attributed to material-related issues (e.g., silicone elasticity), surgical technique variation, or natural facial growth during childhood.

Patient-reported cosmetic satisfaction was high, with 84.1% reporting good to excellent outcomes on the Likert scale. This is a key outcome considering the psychosocial impact of ptosis in children. Feixue et al (21) emphasized the importance of eyelid crease symmetry and natural contour in achieving favorable aesthetic results, which likely contributed to the high satisfaction in our study.

Study Limitations

The single-center design of this study might have made it more difficult to generalize our findings. Additionally, the small sample size limited the ability to perform comparative analyses between the different surgical procedures, and the statistical analysis was restricted to descriptive statistics for the entire cohort, inevitably the study was constrained by its prospective design, which was fixed with a single method based on levator function and only included a one-year follow-up.

Conclusion

This prospective study describes current surgical techniques and approaches for congenital ptosis in a tertiary care facility. Frontalis suspension is still a viable alternative for patients with no levator function. On the other hand, levator resection and conjoint fascial sheath suspension provided functional and cosmetic outcomes with reasonable satisfaction in patients with fair and good levator function. Overall, the individualized surgical approach considering the patient's anatomy, levator function, and other attributes, remains the hallmark of achieving the best results in congenital ptosis.

Source of funding: Nil

Conflict of interest: The authors declare no conflict of interest.

References

1. Chen L, Li J, Zhang C, Li Y, Hou L, Ma J. Surgical interventions for congenital ptosis: a systematic review and meta-analysis of 14 randomized controlled trials. Aesthetic Plast Surg. 2023;47(5):1859-69. doi:10.1007/s00266-023-03360-9
2. Chen YH, Huang PW, Tsai YJ. Factors related to persistent amblyopia after surgical correction in unilateral congenital blepharoptosis. BMC Ophthalmol. 2025; 25:330. doi:10.1186/s12886-025-04169-7
3. Wu X, Zhang J, Ding X, Cao Y, Zhu X, Li R, et al. Amblyopia and refractive status in congenital ptosis: the effect and timing of surgical correction. Ann Plast Surg. 2021;87(1):49-53.
4. Li J, Yu X, Wang K, Meng Z, Liang X, Chen R. Modified conjoint fascial sheath and levator muscle complex suspension for the correction of simple severe congenital ptosis in pediatrics and the effect on refractive status. Ophthalmic Plast Reconstr Surg. 2024;40(4):392-8. doi:10.1097/IOP.0000000000002589
5. Sang P, Fang M, Li X, et al. Treatment of severe ptosis by conjoint fascial sheath suspension. Biomed Res Int. 2021; 2021:1837458.
6. Gandhi A, Mehta A, Naik M. Does frontalis sling surgery for congenital ptosis change the corneal topography and refractive characteristics postoperatively? Clin Ophthalmol. 2020; 14:3667–73.
7. Hoshikawa R, Kamiya K, Fujimura F, et al. Prediction of distance visual acuity in presbyopic astigmatic subjects. Sci Rep. 2021; 11:6958.
8. Wuthisiri W, Peou C, Lekskul A, et al. Maximal levator resection beyond Whitnall's ligament in severe simple congenital ptosis with poor levator function. Clin Ophthalmol. 2022; 16:441–52.
9. Tan Y, Wang X, Fu J, et al. Amblyopic astigmatism characteristics and surgical outcomes in younger children with severe congenital ptosis after frontalis suspension surgery. BMC Ophthalmol.2023; 23:54.
10. Owji N, Khalili MR, Bazrafkan H, Heydari M. Long-term outcome of refractive errors in patients with congenital blepharoptosis whohaveundergoneptosissurgery.ClinExp Optom.2022;105(7):715-20. doi:10.1080/08164622.2021.1973344
11. Ghiam BK, Su RC, Orge F. Surgical outcomes after frontalis suspension using expanded polytetrafluoroethylene sling for congenital ptosis. Cureus. 2023;15(11): e49020. doi:10.7759/cureus.49020
12. Everekliogluc. Frontalis suspension by a minimally invasive "harvesting-stripping technique" for congenital blepharoptosis in children under 3-years-old. Eur J Ophthalmol. 2023; 33:161–70. doi:10.1177/11206721221106133
13. Kasaee A, Aliabadi M, Najafi L, Jamshidian-Tehrani M. Severe unilateral

congenital ptosis with poor levator function: tarsoconjunctival mullerectomy plus levator resection vs frontalis sling procedure. Int J Ophthalmol. 2022;15(8):1254-60. doi:10.18240/ijo.2022.08.05
14. Dallalzadeh LO, Park KS, Korn BS, Kikkawa DO, Liu CY. Minimal dissection direct frontalis muscle advancement flap for congenital ptosis repair. J Craniofac Surg. 2021;32(7):2358–61. doi:10.1097/SCS.0000000000007761
15. Liu NH, He AJ, Wu D, Zhang J, Song N. Modified maximal levator palpebrae superioris shortening in correcting congenital severe ptosis in children. Ann Plast Surg. 2021;87(5):523–7. doi:10.1097/SAP.0000000000002867
16. Mohammed NM, Kamal MA, Abdelhafez MA, Diab MM. Single-triangle versus Fox pentagon frontalis suspension for unilateral severe congenital ptosis correction. J AAPOS. 2020;24(5): 295.e1–295.e6. doi: 10.1016/j.jaapos.2020.06.011
17. Rosenberg JB, Andersen J, Barmettler A. Types of materials for frontalis sling surgery for congenital ptosis. Cochrane Database Syst Rev. 2019;4:CD012725. doi:10.1002/14651858.CD012725
18. Salamah M, Eid AM, Albialy H, Sharaf El Deen S. Anterior approach levator plication for congenital ptosis, absorbable versus non-absorbable sutures. Eur J Ophthalmol. 2021; 1:2–3.
19. Théra JP, Tiama JM, Konipo A, Napo A, Bamani S. Treatment of congenital ptosis in a low-income country: polypropylene frontalis sling at the African Institute of Tropical Ophthalmology. J Fr Ophtalmol. 2020;43(2):123–7.
20. Shome D, Mittal ST, Kapoor R. Effect of eyelid crease formation on aesthetic outcomes post frontalis suspension for unilateral ptosis. Plast Reconstr Surg Glob Open. 2019;7(1): e2039.
21. Ding F, Zhu X, Yang L. Treatment of mild and moderate congenital ptosis via the levator imbrication technique. Chin J Plast Reconstr Surg. 2023;5(4):173–7.

HISTORY	
Date received:	09-09-2025
Date sent for review:	10-11-2025
Date received reviewer's comments:	22-11-2025
Date received revised manuscript:	15-12-2025
Date accepted:	20-12-2025

CONTRIBUTION OF AUTHORS	
AUTHOR	**CONTRIBUTION**
Conception/Design	AQ, NU, AK
Data acquisition, analysis and interpretation	AQ, AK, MA
Manuscript writing and approval	NU, MA, NH
All the authors agree to take responsibility for every facet of the work, making sure that any concerns about its integrity or veracity are thoroughly examined and addressed.	