ORIGINAL ARTICLE

Comparative Analysis of Supraorbital Eyebrow and Pterional Approaches for Cranio-Orbital Injury Management

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Abstract

Background: Cranio-orbital injuries are challenging craniofacial traumas because of the proximity of the orbital contents to vital neurovascular and ocular structures. Although the literature on orbital trauma is extensive, comparative evidence between the supraorbital eyebrow approach (SEA) and the pterional approach (PA) in traumatic cranio-orbital injuries remains limited, particularly in resource-constrained settings. **Materials and Methods:** This retrospective study evaluated the SEA and PA for treating cranio-orbital injuries in 49 patients who underwent 51 surgeries at a tertiary care center in Kyrgyzstan from 2014 to 2017. The main outcomes assessed were the degree of resection, visual function improvement, ptosis resolution, and proptosis reduction. Secondary outcomes included cosmetic satisfaction, post-operative complications, and functional recovery, as assessed using the modified Rankin Scale. **Results:** The SEA was used in 28 patients, whereas the PA was employed in 23 patients. The gross total resection rates were comparable between the two approaches. The SEA group reported higher cosmetic satisfaction and shorter incision lengths than the PA group ($P < 0.05$). Proptosis improved in 98.0% of cases, and visual function was enhanced in 63.2% of patients with pre-operative impairment. Ptosis resolved in most cases, with no significant differences between the surgical approaches used. At ≥12 weeks follow-up, 89.2% of patients attained a modified Rankin Scale score of <3, indicating independence in daily activities. Complications were infrequent, with no significant intergroup differences observed. **Conclusion:** The study suggests that The SEA is ideal for smaller anterior lesions, providing superior cosmetic results and lower morbidity, whereas the PA remains essential for larger or complex lesions requiring extensive exposure.

Key words: Cranio-orbital injuries, pterional approach, resection, supraorbital eyebrow approach, visual function

INTRODUCTION

Cranio-orbital injuries are challenging craniofacial traumas because of the proximity of the orbital contents to vital neurovascular and ocular structures. These injuries often result from high-impact events, such as traffic collisions, falls, and blunt force trauma.[1-3] Symptoms include proptosis, visual disturbances, ptosis, and cosmetic deformities, which often require surgical treatment.[4,5]

Surgical techniques for cranio-orbital conditions have advanced significantly in recent years. The supraorbital eyebrow (SEA) method offers a less invasive approach for accessing superior orbital and anterior cranial base lesions, with shorter incisions, lower operative morbidity, and better cosmetic results than traditional methods. The pterional approach (PA) remains the standard for treating deeper or extensive lesions requiring wide exposure.[6-9] Studies have shown that while SEA achieves high cosmetic satisfaction (>90%), it may not be suitable for large or complex lesions. PA is associated with higher temporalis muscle atrophy and esthetic issues.[10-13]

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Table 1: Baseline characteristics of patients who underwent surgery

S. No.	Variables	Supraorbital (*n*=28)	Pterional (*n*=23)	Total (*n*=51)	*P*-value
1.	Mean age, years	41.9	41.9	41.9	-
2.	Males (%)	–	–	16 (32.7)	-
3.	Females (%)	–	–	33 (67.3)	-
4.	Reoperation cases (%)	1 (3.6)	1 (4.3)	2 (3.9)	-
5.	Prior surgery (%)	6 (21.4)	7 (30.4)	13 (25.5)	0.121

Data presented as *n* (%), *n*: Number of patients, %: Percentage of patients, *n*: Total no. of patients, Mean±Standard Deviation (M±m). **P*<0.05

Table 2: Comparative outcomes of supraorbital and pterional approaches

S. No.	Outcomes	Supraorbital (*n*=28)	Pterional (*n*=23)	*P*-value
1.	Lesions treated	22	29	-
2.	Gross-total resection (%)	16/22 (72.8)	Comparable	>0.05
3.	Incision length, cm	12.5±0.9	5.4±1.1	0.001
4.	Cosmetic satisfaction	Higher	Lower	<0.05
5.	Proptosis at presentation (%)	25 (89.3)	22 (95.6)	-
6.	Proptosis improvement (%)	27 (96.4)	21/23 (91.3)	>0.05
7.	Visual impairment at baseline	13	20	-
8.	Visual improvement (%)	12/19 (63.1)	–	>0.05
9.	Ptosis resolution	Present	Present	>0.05

Data presented as *n* (%), *n*: Number of patients, %: Percentage of patients, Mean±Standard deviation (M±m). **P*<0.05

Computer-assisted navigation and 3D reconstruction have enhanced the accuracy of surgery, implant placement, and orbital volume restoration.[14,15] However, challenges such as post-operative diplopia, enophthalmos, and visual impairment persist. Although the literature on orbital trauma is extensive, comparative evidence between SEA and PA in traumatic cranio-orbital injuries remains limited, particularly in resource-constrained settings.

This study evaluated SEA and PA methods in terms of the completeness of resection, recovery of visual and functional abilities, cosmetic results, and surgical complications in cranioorbital injuries.

MATERIALS AND METHODS

In this retrospective study, the medical records of 49 patients who underwent 51 cranio-orbital surgeries were examined. These patients were treated at the Department of Neurotraumatology, Kyrgyz State Medical Academy from 2014 to 2017. The study protocol was approved by the Bioethics Committee of the Kyrgyz State Medical Academy (approval no. 01/17, September 01, 2017). Informed consent for surgery and study participation was obtained from all patients or their legal guardians.

Individuals were included if they had confirmed cranio-orbital injuries determined by clinical assessment and neuroimaging (computed tomography and/or magnetic resonance imaging), showed clear reasons for surgery, such as worsening proptosis, vision problems, drooping eyelids, optic nerve compression, or cosmetic deformity, and were 18 years or older. Patients were excluded if they had cranial trauma without orbital involvement, severe comorbidities preventing surgery, inadequate clinical or follow-up data for outcome evaluation, or declined study participation.

Two surgical techniques were used in this study. The supraorbital (eyebrow) approach was used in 28 patients, including one with recurrence requiring repeat surgery via the same route. The pterional technique was used in 21 patients, with one recurrence addressed using the same method. The surgical approach depended on the lesion location and size, presence of hyperostosis, and need for orbital and cranial exposure. The supraorbital path was favored for smaller lesions above the optic nerve, whereas the PA was chosen for extensive conditions requiring wider access.

The main outcomes assessed were the degree of resection (complete vs. partial), visual function enhancement, drooping eyelid resolution, and reduced bulging eyes. Secondary outcomes included cosmetic satisfaction, post-operative complications such as cerebrospinal fluid leakage or new neurological and ocular impairments, and functional recovery assessed using the modified Rankin Scale with a minimum 12-week follow-up.

Descriptive statistics were used to summarize the baseline characteristics. Continuous variables are expressed as mean ± standard deviation and were compared using Student's *t*-test or Mann–Whitney U-test, based on distribution. Categorical variables were analyzed using the χ^2 test or Fisher's exact test. Statistical significance was set at $P < 0.05$.

RESULTS

This study included 49 patients who underwent 51 surgeries. Of these, 28 and 23 patients underwent the supraorbital

Table 3: Functional outcomes and post-operative complications during follow-up

S. No.	Outcomes	Supraorbital (*n*=28)	Pterional (*n*=23)	Total (*n*=51)	*P*-value
1.	Modified rankin scale <3 at ≥12 weeks	–	–	33 (89.2%)	>0.05
2.	Persistent deficit	–	–	–	-
3.	Cerebrospinal fluid leak	Low, comparable	Low, comparable	–	>0.05
4.	Dural reconstruction	Cases with defects	Cases with defects	23	–
5.	Orbital roof repair with titanium mesh	–	–	23	–

Data presented as *n* (%), *n*: Number of patients, %: Percentage of patients. *$P<0.05$

and PA, respectively. In each group, one patient required a second operation owing to recurrence. The mean age of the participants was 41.9 years, with 16 men and 33 women. The baseline demographics were similar across both groups [Table 1].

In the supraorbital group, 22 lesions were addressed, of which 15 were fully resected. In the pterional group, 29 lesions were treated, achieving comparable gross-total resection rates ($P > 0.05$). Prior surgery was noted in 8/22 (36.4%) and 5/29 (17.2%) patients in the supraorbital and pterional groups, respectively ($P = 0.121$). The skin incision length was shorter in the pterional group (5.4 ± 1.1 cm) than in the supraorbital group (12.5 ± 0.9) ($P = 0.001$). Patients who underwent supraorbital surgery reported higher cosmetic satisfaction ($P < 0.05$) [Table 2].

Proptosis was the most common initial symptom in 95.9% of cases (47 out of 49), followed by visual impairment in 33 patients, including 12 cases of pre-operative blindness. In addition, 11 patients had headaches and seven had ocular motility disorders. After surgery, proptosis improved in 98.0% of cases (48 out of 49), although two patients developed mild enophthalmos and one required enucleation. Of the 19 patients with visual impairment, 12 (63.2%) improved, 1 (5.3%) declined, and 6 (31.5%) showed no change. Ptosis resolved in most cases, with no notable differences between the surgical approaches [Table 2].

Follow-up data for ≥12 weeks were available for 37 patients. Among these, 33 patients (89.2%) attained a modified Rankin Scale score of <3, indicating independence in daily activities [Table 3]. Complications such as cerebrospinal fluid leakage, new neurological deficits, or eye-related issues were infrequent, with no significant intergroup differences ($P > 0.05$). Artificial dura was used for dural defect reconstruction. In 23 patients with orbital roof defects >3 cm, a three-dimensional titanium mesh was used for reconstruction.

DISCUSSION

This study shows both SEA and PA methods effectively treat cranio-orbital injuries, with variations in satisfaction, incision length, and exposure. Results indicate SEA provides better cosmetic outcomes, aligning with reviews showing eyebrow incisions yield favorable esthetic outcomes for over 90% of patients.[10,11] Patients expressed high satisfaction due to minimal scarring and less temporalis muscle morbidity, consistent with findings of La Rocca *et al*. and Elsharkawy and Abdelhameed.[12,13]

Visual outcomes were favorable, with two-thirds of patients showing improvement after surgery. This aligns with research highlighting the importance of prompt surgical decompression of the optic nerve for maintaining vision.[4,16,17] Almost all patients experienced reduced proptosis, consistent with radiological and surgical findings that indicate orbital decompression helps restore eye position and enhance function.[9,18]

Although not the most esthetically pleasing option, the PA remains crucial for accessing lesions requiring significant exposure of cranial and orbital regions. Our findings align with Dolenc and later research, which emphasized the PA as a dependable route for complex skull base conditions.[6,7,19] Nonetheless, cosmetic deformity and atrophy of the temporalis muscle are well-documented drawbacks,[8,20]

In our study group, advancements in orbital reconstruction using titanium mesh and navigation guidance were evident, as defects over 3 cm required additional support. This aligns with findings that three-dimensional implants enhance volume restoration and decrease enophthalmos.[14,15] However, some patients experienced lasting visual impairments, underscoring permanent optic nerve damage, as previously reported.[16,17]

This study suggests SEA is ideal for esthetic results and minimally invasive techniques, whereas PA suits larger lesions needing greater exposure. To enhance selection criteria, confirm functional results, and assess quality of life, larger multicenter studies with extended follow-up are necessary.

This study has several limitations. Its retrospective nature carries risks of selection and information bias, relying on existing medical records. The small sample size (49 patients, 51 procedures) limited the statistical power to detect differences between the approaches and may have affected generalizability.

The diversity of cranio-orbital lesions in the cohort complicated direct technique comparison. While baseline demographics were similar across groups, unmeasured confounders, such as surgeon preference, intraoperative decisions, and post-operative rehabilitation, could not be fully controlled.

The 12-week minimum follow-up, while sufficient for early outcomes, may not capture long-term effects, such as delayed enophthalmos or progressive visual decline. Functional recovery was measured using the modified Rankin Scale and patient satisfaction; the lack of standardized ophthalmologic assessments limits outcome evaluation.

This single-center experience from a tertiary care institution in Kyrgyzstan provides insight into surgical practice in a resource-constrained setting, although the results may not apply to centers with different populations, expertise, or access to advanced technologies.

CONCLUSION

Both the SEA and PA approaches effectively manage cranio-orbital injuries and offer unique benefits. The SEA approach provides superior cosmetic results and lower morbidity and is ideal for smaller anterior lesions. The PA is essential for larger or complex lesions requiring extensive exposure, despite the potential for temporalis muscle atrophy.

This study shows that selecting approaches based on lesion characteristics and patient factors leads to favorable outcomes. Patients in both groups demonstrated improved proptosis and visual outcomes, with few complications and good recovery.

However, the limitations of this single-center study, including the small sample size and short follow-up period, indicate the need for larger, prospective studies. Future research should include standardized assessments, longer follow-up periods, and quality of life measures to optimize surgical decision-making and patient outcomes.

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