Supraorbital Keyhole Approach: Our Experience with a Minimally Invasive Neurosurgical Technique

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Abstract

The Supraorbital Keyhole Approach (SKA) represents a minimally invasive neurosurgical technique developed to access anterior cranial base and sellar/suprasellar lesions while minimizing soft tissue disruption and brain retraction. Originally introduced within the keyhole surgery philosophy, SKA has progressively expanded its indications thanks to advancements in microsurgical instruments, endoscopic assistance, and preoperative imaging. We present a monocentric retrospective experience of 32 adult patients treated via SKA between 2018 and 2025. Surgical, functional, and radiological outcomes were analyzed to evaluate the safety, efficacy, and reproducibility of this approach. Gross total resection was achieved in the majority of cases, with low complication rates and favorable functional outcomes, particularly regarding visual preservation. Our results confirm SKA as a reliable and effective alternative to traditional craniotomies in carefully selected patients, in line with previously published series [1–3].

Introduction

The evolution of neurosurgical techniques has progressively shifted toward minimizing iatrogenic injury while preserving oncological radicality. In this context, minimally invasive approaches aim to reduce brain exposure, cerebral retraction, and soft tissue trauma without compromising surgical effectiveness. The Supraorbital Keyhole Approach (SKA), first popularized by Perneczky, embodies this philosophy by providing a focused subfrontal corridor through a limited supraorbital craniotomy and eyebrow incision [2,4].

Compared with traditional approaches such as pterional or orbitozygomatic craniotomies, SKA offers several advantages, including reduced operative morbidity, shorter hospital stay, and improved cosmetic outcomes [1,5]. Previous studies have demonstrated that, for selected anterior cranial base meningiomas and suprasellar lesions, SKA achieves tumor control rates comparable to standard approaches while limiting approach-related complications [1,2]. The present study aims to report our institutional experience with SKA across a heterogeneous tumor population, extending beyond meningiomas, and to evaluate its clinical applicability and outcomes.

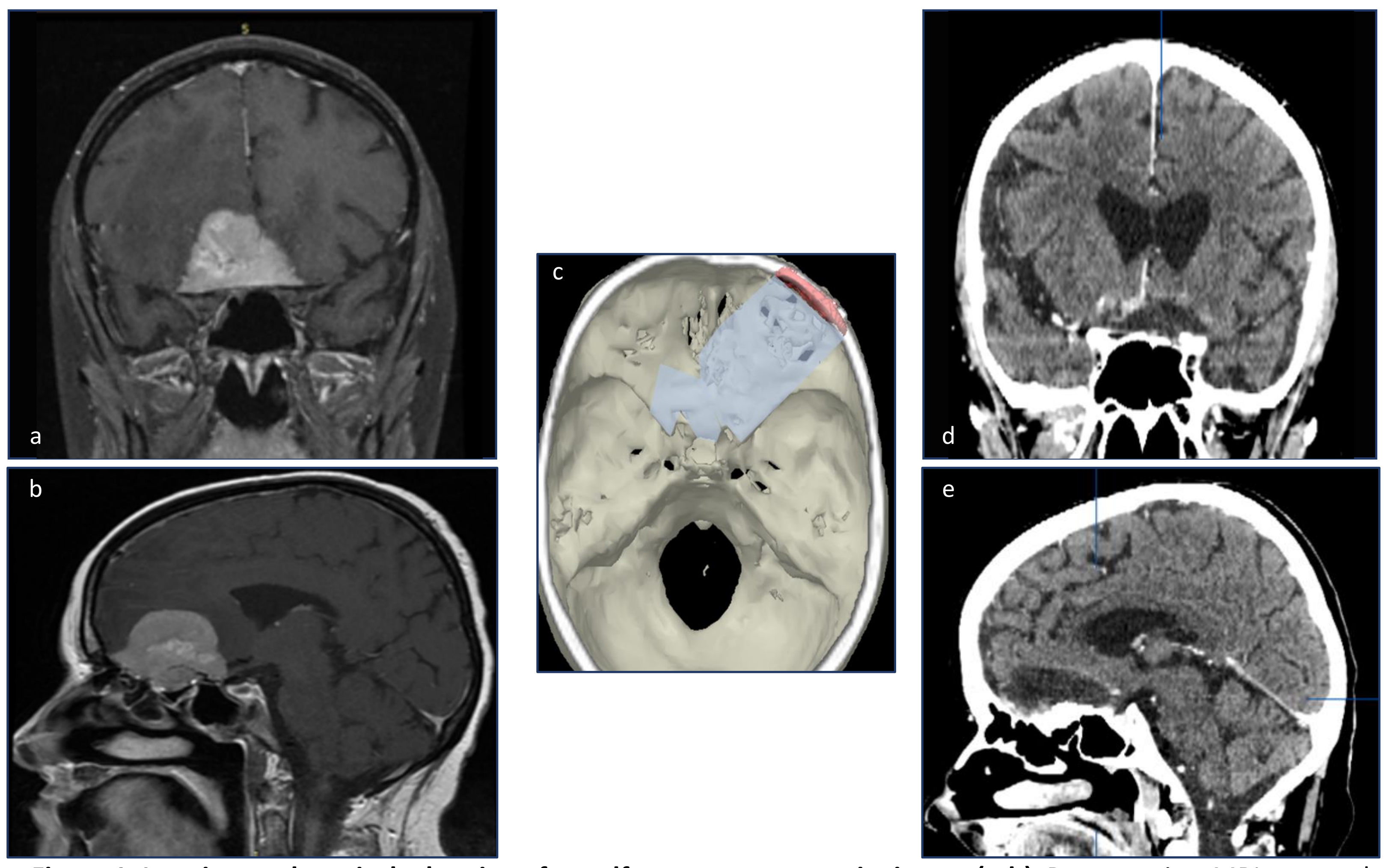

Figure 1. Imaging and surgical planning of an olfactory groove meningioma. (a-b) Preoperative MRI, coronal and sagittal view. **(c)** 3-D rendering illustrating the planned supraorbital surgical exposure. **(d–e)** Postoperative CT scans demonstrating tumor resection.

Materials and Methods

We conducted a retrospective monocentric analysis of 32 adult patients who underwent tumor resection via SKA at the Neurosurgery Clinic of Ancona between January 2018 and August 2025. Inclusion criteria comprised anterior cranial base, sellar/suprasellar, and selected frontal intra-axial tumors deemed suitable for a supraorbital corridor based on preoperative imaging.

Clinical data included demographic characteristics, presenting symptoms, neurological status, and visual function. Radiological evaluation consisted of pre- and postoperative MRI, with particular attention to tumor size, extension, vascular relationships, and extent of resection. Histopathological diagnoses were obtained in all cases. Surgical technique followed the standard eyebrow incision and supraorbital minicraniotomy, with microscope and endoscope assistance when required, consistent with previously described methods [1,4]. All patients had a minimum clinical and radiological follow-up of one month.

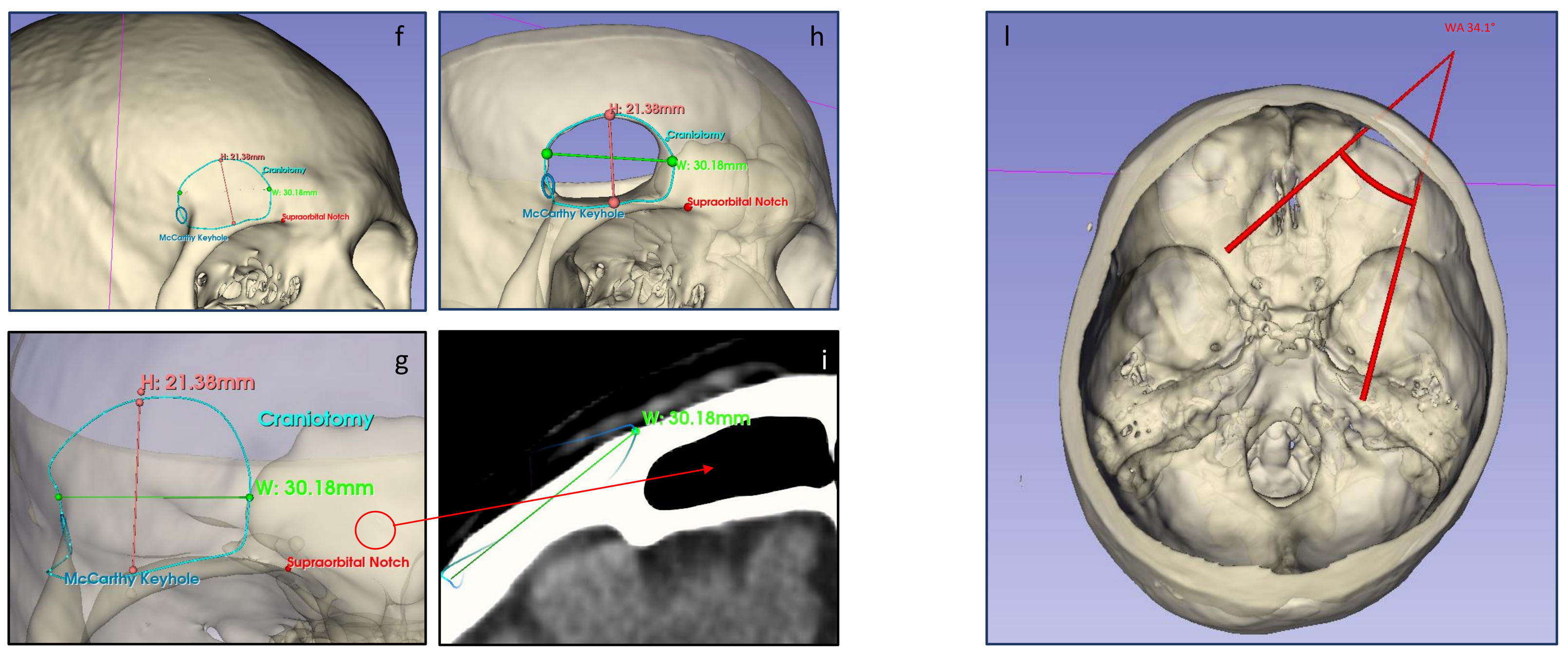

Figure 2. Preoperative 3D planning for the supraorbital keyhole approach. (f–i) 3D renderings illustrating surgical planning, with detailed assessment of frontal sinus pneumatization and supraorbital craniotomy trajectory. **(l)** Evaluation of the surgical working angle (34.1°)

Results

The median patient age was 55 years. Histopathology revealed 21 anterior cranial base meningiomas (65.6%), including three atypical meningiomas, eight sellar/suprasellar lesions (25%; pituitary adenomas and craniopharyngiomas), and three frontal intra-axial tumors (9.4%). Gross total resection was achieved in 84.4% of cases, with Simpson grade I–II resection in 81% of meningiomas, consistent with historical SKA series [1,2].

Preoperative visual deficits were present in 15 patients and improved postoperatively in two-thirds of cases, with no deterioration observed. Early postoperative complications were limited and included cerebrospinal fluid leakage (3.1%), transient supraorbital hypoesthesia (6.3%), transient frontalis branch weakness (3.1%), and surgical site infection (3.1%). No perioperative mortality occurred. Median length of hospital stay was four days, confirming the reduced postoperative burden associated with SKA [1,3].

Table 1. Tumor characteristics

n.	Histology	Localization	Side	D (cm)
1	Meningioma	Tuberculum Sellae	Dx	2.67
2	Meningioma	Tuberculum Sellae	Dx	2.01
3	Meningioma	Tuberculum Sellae	Sn	3.14
4	Meningioma	Planum Sphenoidale	Dx	3.94
5	Meningioma	Planum Sphenoidale	Sn	4.32
6	Meningioma	Frontal	Dx	4.12
7	Meningioma	Frontal	Dx	3.85
8	Meningioma	Frontal	Sn	3.56
9	Meningioma	Olfactory Groove	Dx	2.58
10	Meningioma	Olfactory Groove	Dx	3.76
11	Meningioma	Olfactory Groove	Sn	4.11
12	Atypical Meningioma	Planum Sphenoidale	Dx	3.43
13	Atypical Meningioma	Olfactory Groove	Sn	3.15
14	Craniopharyngioma	Parasellar	Dx	2.62
15	Craniopharyngioma	Parasellar	Dx	1.89
16	Pituitary Adenoma	Sellar	Dx	2.10
17	Pituitary Adenoma	Sellar	Dx	2.78
18	Oligodendroglioma	Frontal	Sn	4.46
19	Glioblastoma	Frontal	Sn	4.08
20	Atypical Neurocytoma	Frontal	Dx	2.72

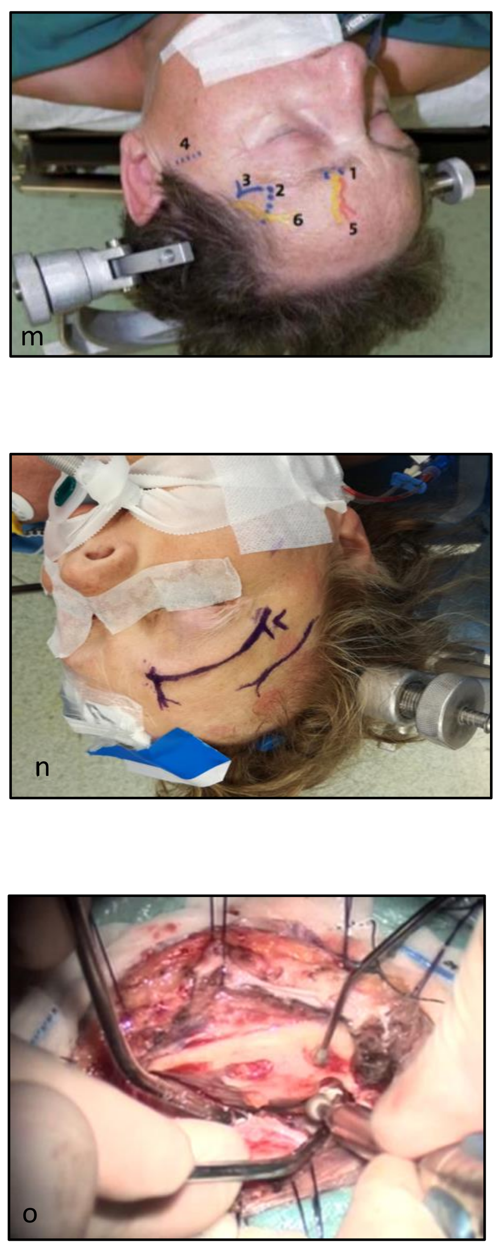

Figure 3.
Preoperative landmarks and surgical exposure in the supraorbital keyhole approach. (m–n) Preoperative images showing anatomical landmarks and planned eyebrow skin incision. **(o)** Intraoperative view after supraorbital craniotomy, demonstrating the surgical exposure

Discussion

Our findings support the growing body of evidence indicating that SKA is a safe and effective minimally invasive alternative for selected skull base and suprasellar tumors. The philosophy underlying SKA emphasizes "maximal effectiveness with minimal exposure," reducing brain manipulation and preserving neurovascular structures [2,4]. Compared with traditional craniotomies, our complication rates and extent of resection are comparable or favorable, in agreement with previously published experiences [1,5].

Careful patient selection remains crucial. Tumors with extensive lateral extension, severe bifrontal edema, or encasement of major vessels may still benefit from conventional approaches, as highlighted in earlier reports [1,2]. Endoscopic assistance and meticulous skull base reconstruction techniques are essential to optimize visualization and minimize cerebrospinal fluid leakage [3,6].

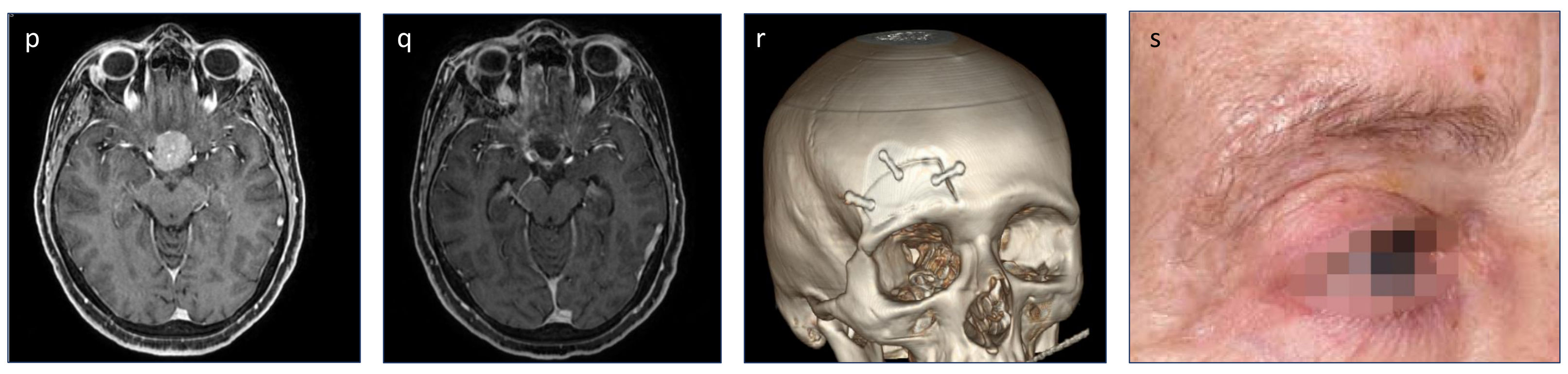

Figure 4. Radiological and aesthetic outcomes following the supraorbital keyhole approach. (p) Preoperative axial MRI. **(q)** Postoperative axial MRI demonstrating complete tumor resection. **(r)** 3D rendering of post-op. CT scan showing accurate repositioning of the craniotomy flap. **(s)** Photograph at 2-month follow-up demonstrating optimal cosmetic outcome.

Conclusions

The Supraorbital Keyhole Approach is a valuable minimally invasive technique for the management of selected anterior cranial base and sellar/suprasellar tumors. Our experience demonstrates high resection rates, low morbidity, rapid recovery, and excellent functional outcomes, particularly regarding visual function. When applied in appropriately selected patients and combined with meticulous surgical technique, SKA represents a sound alternative to traditional craniotomies.

Contact

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