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The Utility of Neuroendoscopic Approach for Pineal Region Lesions: Single-Centre Experience

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ABSTRACT

AIM: To investigate the treatment approaches and follow-up data of patients with pineal region tumours at our institution.

MATERIAL and METHODS: A retrospective study was planned to evaluate patients who diagnosed with a pineal mass between 2019 and 2022 whether incidentally or symptomatically. All patients were evaluated regarding their radiological findings, clinical, labrotary and radiological outcomes of surgery if any performed, intraoperative and postoperative pathological diagnoses, and radiological and symptomatic follow-up results for at least one year.

RESULTS: A total of 16 patients were grouped into 2; intervention and conservation groups, respectively. Nine out of 16 patients received intervention (surgery with or without ionising radiation therapy) and remained 7 followed up without intervention. Seven patients in the intervention group were found to have triventricular hydrocephalus, and one had tetraventricular hydrocephalus. Endoscopic approach was the preferred surgical intervention in all operated patients which was conventional endoscopic third ventriculostomy (ETV) via a right-sided frontal burr hole. Five patients required a simultaneous external ventricular drain. Neuronavigation was used in all the procedures.

CONCLUSION: Neuroendoscopic intervention is a relatively safe, effective, low-cost initial procedure with low morbidity rates and enables patients to return daily life rapidly. Neuroendoscopy is the best approach for simultaneously providing tissue sampling and diversion of cerebrospinal fluid via ETV or septostomy in hydrocephalic patients with tumours in the pineal region.

KEYWORDS: Biopsy, Hydrocephalus, Neuroendoscopy, Pineal, Third ventriculostomy

INTRODUCTION

Pineal region tumours constitute a heterogeneous group of neoplasms that account for 0.6%–0.9% of all brain tumours (6). Tumours in this group include parenchymal tumours, germ cell tumours, and neuroectodermal tumours (6, 13) Conventional open, endoscopic, and stereotaxic surgical procedures are the main approaches for providing clinical relief or obtaining a pathological diagnosis that may guide and optimise the treatment. However, to decide the above-mentioned treatment options might seem complicated that include observation with the close follow-up, biopsy, symptomatic approach (treating hydrocephalus etc.) and/or total resection of the tumour.

A minimally invasive treatment modality that may solve both symptoms and provide tissue samples is desirable. Neuroendoscopy has been considered feasible to provide such solutions. Herein, we aimed to demonstrate the benefits and drawbacks of neuroendoscopic approach in patients with pineal region tumours at our institution.

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MATERIAL and METHODS

A retrospective study was planned to evaluate patients with pineal region lesions who admitted to Ankara University, School of Medicine, Department of Neurosurgery clinic in between 2019-2022 with the approval of institutional Ethical Boardv (Decision no: İ03-243-24, Date: 03.04.2024). Patients were grouped into 2; conservation group without any surgical intervention (which is our control group) and intervention group who received surgery. All patients' diagnostic radiological findings, the surgical intervention (if performed), intraoperative and postoperative pathological diagnoses (if surgery performed), and radiological as well as symptomatic follow-up results were evaluated. Patients for whom follow-up data were missing and/or follow up period less than a year, patients with hydrocephalus caused by masses other than pineal origin, patients with a history of idiopathic primary malignity history or those who had undergone previous intracranial interventions were excluded.

RESULTS

A total of 17 patients had met the inclusion criteria and included during evaluation. They are diagnosed with pineal mass whether incidentally or after presentation with headache and dizziness. Patients who exhibited no hydrocephalus or related symptoms, low levels or absence of HCG and AFP in their serum were scheduled for clinical follow-up without surgical intervention. One patient diagnosed with pineal germinoma and scheduled for radiotherapy without attaining a pathological sample. Hydrocephalus was absent as well and the patient received 5 doses of radiotherapy, radiologically relieved of the tumour in 4 years with silent clinical course. Nine patients diagnosed with pineal mass related hydrocephalus and scheduled for simultaneous endoscopic third ventriculostomy and biopsy.

Almost all operated patients presented with headache and dizziness; and one presented with double vision. The mean age of the patients was 34.8 years (range, 16–67 years); seven were female and three were male.

The mean diameter of the tumours was 24 mm (range, 20–36 mm). Seven patients were found to have triventricular hydrocephalus, and one had tetraventricular hydrocephalus. The radiological features of the cases are listed in Table I.

Biopsy was the initial surgical procedure in all patients (Table II). A conventional endoscopic third ventriculostomy (ETV) via a right-sided frontal burr hole was performed in all the patients. Five patients required a simultaneous external ventricular drain (EVD) to ensure safety after minimal bleeding. The EVD was removed on the 1st-2nd postoperative days. Neuro-navigation was used in all the procedures. No massive bleeding or any temporary complication was observed. EVD infection was detected in one patient who had responded well to antibiotic therapy. The mean length of hospitalization was 7.2 days for the other seven patients; the patient with EVD infection was hospitalized for 17 days for parenteral antibiotic treatment. Figures 1, 2 and 3 depict the preoperative and follow-up radiological findings in three patients who underwent ETV, biopsy, and EVD placement for the pineal region tumour.

The mean follow-up time was 29.9 months (range, 2–53 months). During this period, four patients (40%), one that with previous EVD infection, required ventriculoperitoneal shunting. Nine patients did not require any additional procedure for the tumour; the histopathological diagnosis obtained through biopsy guided further treatment (chemotherapy and/or radiotherapy). In the other patient, suboccipital craniectomy and tumour resection via supracerebellar infratentorial approach was performed 2 months after biopsy (for papillary tumour, grade II) because of sudden deterioration in vision and increasingly severe headache.

DISCUSSION

Pineal region tumours are very rare lesions of the nervous system (1,2). The critical neural structures in that region and the deep location of the lesions may complicate any microsurgical treatment. Conventional treatment approaches involve neo-adjuvant chemotherapy before tumoural resection for nongerminomatous germ cell tumours (11) Depending on the high serum concentration and their increase trend, cyto-reduction and biopsy might be considered as the initial treatment approaches.

Recent developments in minimally invasive neurosurgery and the popularity of neuroendoscopy have influenced surgeons to prefer biopsy over excision in such cases (2,3,9). Each patient's case was discussed in our institutional consultative academic council with regard to the best approach. Intervention for hydrocephalus as well as tissue sampling via neuroendoscopy was the initial method suggested for all patients.

Neuroendoscopy is known to facilitate surgical maneuvers because neurovascular structures are easily visualized and identified (7,8). Histopathological analysis helps guide the extent of resection for neoplasms such as pineal region tumours. The rate of success of endoscopic biopsy was reported to be as high as 87.9%–100%; however, diagnostic errors are more likely to occur with biopsies for germ cell tumours (3,8,10,15). Flexible endoscopy provides excellent maneuverability even in small ventricles; on the other hand, complication rates are as high as 13%–15% in these cases, (1,4). In general, we agree that biopsy errors in diagnosing a histologically heterogeneous lesion may be result from insufficient sample sizes and restriction of the sampling area to only one site. In our practice, we obtain as many tissue samples as possible from all accessible tumour regions to minimize diagnostic errors. However, as it was in six of our patients (patient 3-5 and 7, 9, 10), the pathological analysis may fail to provide reliable results due to factors such as insufficient tissue sample, etc. In these cases, the ETV relieved the symptoms and close radiological follow up (an MRI every six months) revealed stability in terms of lesion size and contrast enhancement features. According to our experience from these cases, close follow up should be recommended in clinically and radiologically stable lesions where the pathological diagnosis is not fully accurate and reliable.

Table I: Main Pathological Characteristics, Treatment, and Follow-Up Data of the Patients

Patient	Lesion Size (mm); Preoperative	MRI Characteristics	Gadolinum Enhancemet	Operation	Histopathological Diagnosis	Postoperative Adjuvant Ionising Radiation Therapy	Postoperative Adjuvant Chemotherapy	3rd Ventricule Transvers/Anteroposterior Diameter at Diagnosis (mm)	Ventriculoperitoneal Shunting During Follow-up	Postoperative Follow-up, Lesion size in mm; 3rd Month	Postoperative Follow-up, Lesion size in mm; 12th Month	Postoperative Follow-up, Lesion size in mm; 24th Month	Postoperative Follow-up, Lesion size in mm; 36th Month	Radiological Result	Clinical Result	Follow-up Month
1	24x19x17	T1 Isointens / T2 Hyperintense	+	ETV+Bx+EVD	Papillary tumor, Grade II	IGRT	-	14/27	-	25x22x18	23x21x17	24x20x18	24x22x17	Stable	Asympto-matic	53
2	21x22x21	T1 Hypo / T2 Hyperintense	+	ETV+Bx+EVD	Pineocytoma, Grade I	IGRT+IMRT	-	18/24	-	20x19x21	18x19x19	13x12x14	-	Regression	Asympto-matic	24
3	22x20x17	T1 Isointens / T2 Hyperintense	+	ETV+Bx	Pineoblastoma	-	-	10/28	+	20x14x16	23x20x17	25x20x17	-	Stable	Asympto-matic	24
4	30x27x29	T1 Hypo / T2 Hyperintense	-	ETV+Bx	Pineoblastoma	-	-	16/19	-	35x20x30	35x20x30	35x20x30	-	Stable	Asympto-matic	24
5	20x17x15	T1 Hypo / T2 Hyperintense	+	ETV+Bx	Pineoblastoma	-	-	14/16	-	17x19x15	19x19x15	20x18x18	19x17x15	Stable	Asympto-matic	36
6	36x23x20	T1 isointens / T2 Hyperintense	+	ETV+Bx+EVD	Germinoma	IMRT + Tomotherapy	BEP, 3 cycles	12/19	+	18x8x7	15x4x5	15x4x6	3x2x3	Regression	Asympto-matic	36
7	23X21X22	T1 isointens / T2 Hyperintense	+	ETV+Bx+EVD	Pineoblastoma	-	-	18/23	-	21X21X22	21X22X22	23X21X21	22X22X23	Stable	Asympto-matic	40
8	26x25x23	T1 isointens / T2 Hyperintense	+	ETV+Bx+EVD	Atypical choroid plexus papilloma	IMRT	-	16/20	+	25x25x23	26x25x22	26x23x25	-	Stable	Asympto-matic	24
9	22x27x17	T1 Hyperintense/ T2 Isointense	+	ETV+Bx	Not Specified	-	-	13/30	-	-	20x25x14	-	20x24x14	Regression	Asympto-matic	36

ETV: *Endoscopic third ventriculostomy,* ***Bx:*** *Biopsy,* ***EVD:*** *External ventricular drain,* ***RT:*** *Radiation therapy,* ***ChT:*** *Chemotherapy,* ***IGRT:*** *Image-guided radiation therapy,* ***IMRT:*** *Intensity-modulated radiation therapy,* ***BEP:*** *bleomycin, etoposide, and cisplatin.*

Table II: Radiologic Diagnosis, Sizes and Radiologic Characteristics Together with Existence of Hydrocephalus in Follow Ups of Non-Operated Patients with Pineal Region Lesions.

Patient	Lesion Size (mm); Preoperative	MRI Characteristics	Gadolinum Enhancemet	Radiological Diagnosis	3rd Ventricule Transvers/ Anteroposterior Diameter at Diagnosis (mm)	Hydrocephalus	Postoperative Adjuvant Ionising Radiation Therapy	Postoperative Adjuvant Chemotherapy	Follow-up, Lesion size in mm; 12th Month	Follow-up, Lesion size in mm; 24th Month	Follow-up, Lesion size in mm; 36th Month	Radiological Result	Clinical Result	Follow-up Month
1	6x7x9 mm	T1 hypointense / T2 hyperintense	-	Pineal cyst	16/19	Absent	-	-	NA	NA	NA	-	Asymptomatic	None
2	7x10x8 mm	T1 hypointense / T2 hyperintense	-	Pineal cyst	12/19	Absent	-	-	NA	NA	NA	-	Asymptomatic	None
3	13x15x8 mm	T1 hypointense / T2 hyperintense	-	Pineal cyst	10/28	Absent	-	-	NA	NA	NA	-	Asymptomatic	None
4	4x10x6 mm	T1 isointense / T2 isointense	+	Germinoma	14/10	Absent	+ (54 Gy)	-	9,5x7x7,5	7x6x6	Vanished	Regression	Asymptomatic	60 months
5	15x12x10 mm	T1 hypointense / T2 hyperintense	+	Solid nodule	18/24	Absent	-	-	10x10x10	12x11x10	Ongiong	Minimal progression	Asymptomatic	Ongoing
6	8x6x6 mm	T1 hypointense / T2 hyperintense	-	Septated cyst	12/19	Absent	-	-	NA	NA	NA	-	Asymptomatic	None

Lat: *Lateral,* ***AP:*** *Anteroposterior,* ***Vert:*** *Vertical,* ***RT:*** *Radiation therapy,* ***NA:*** *Not available data.*

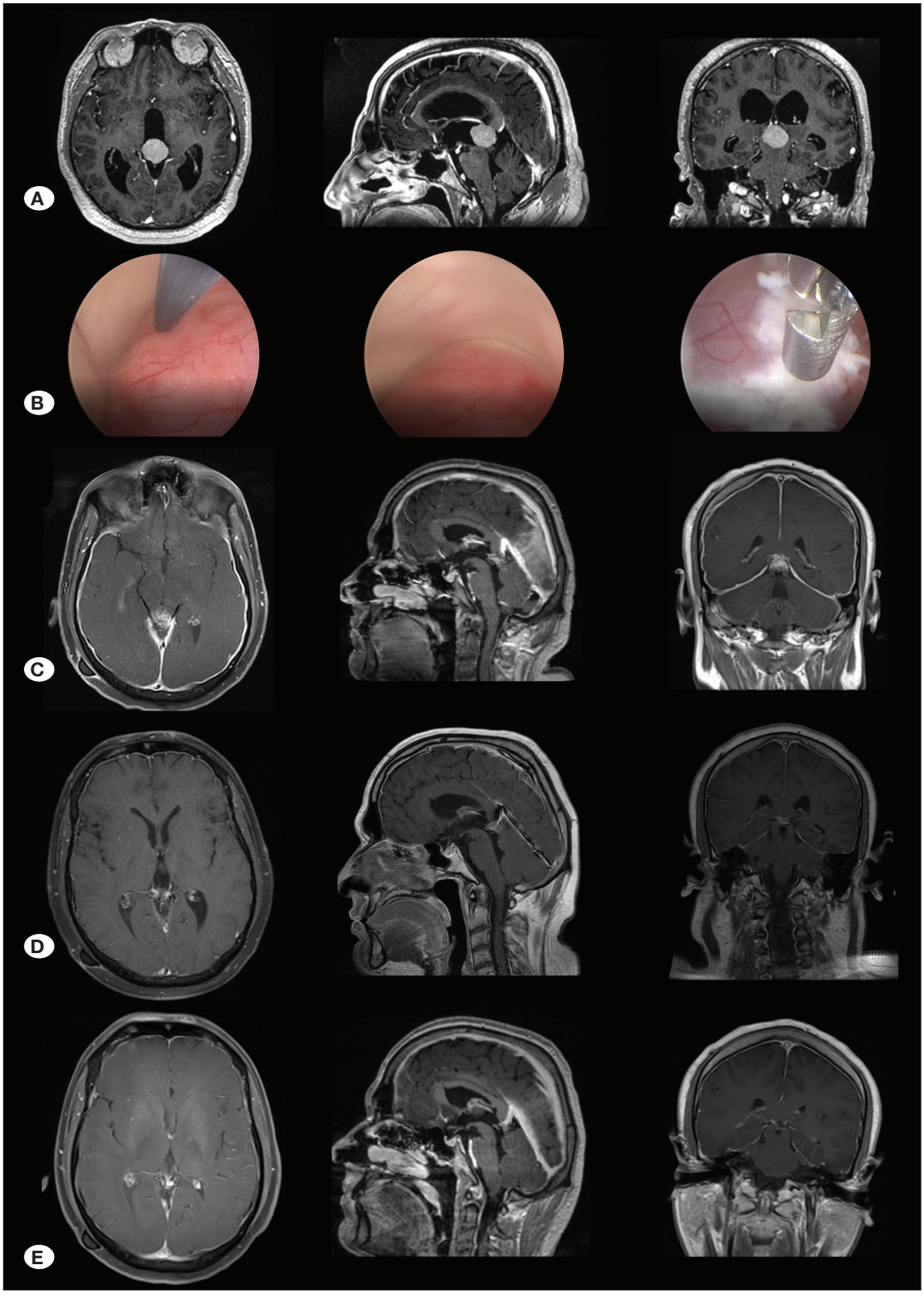

Figure 1: Sagittal, coronal, and axial gadolinium-enhanced T1-weighted magnetic resonance images (MRIs) showing a pineal lesion (Pineasitoma,, grade I) extending into the posterior aspect of the third ventricle. **A)** Preoperative MRI. **B)** Intraoperative images during ETV, tumour exploration and biopsy, respectively. **C)** Early postoperative and post image-guided & intensity-modulated radiation therapy MRI. **D)** Six-month follow-up MRI. **E)** Twelve-month follow-up MRI.

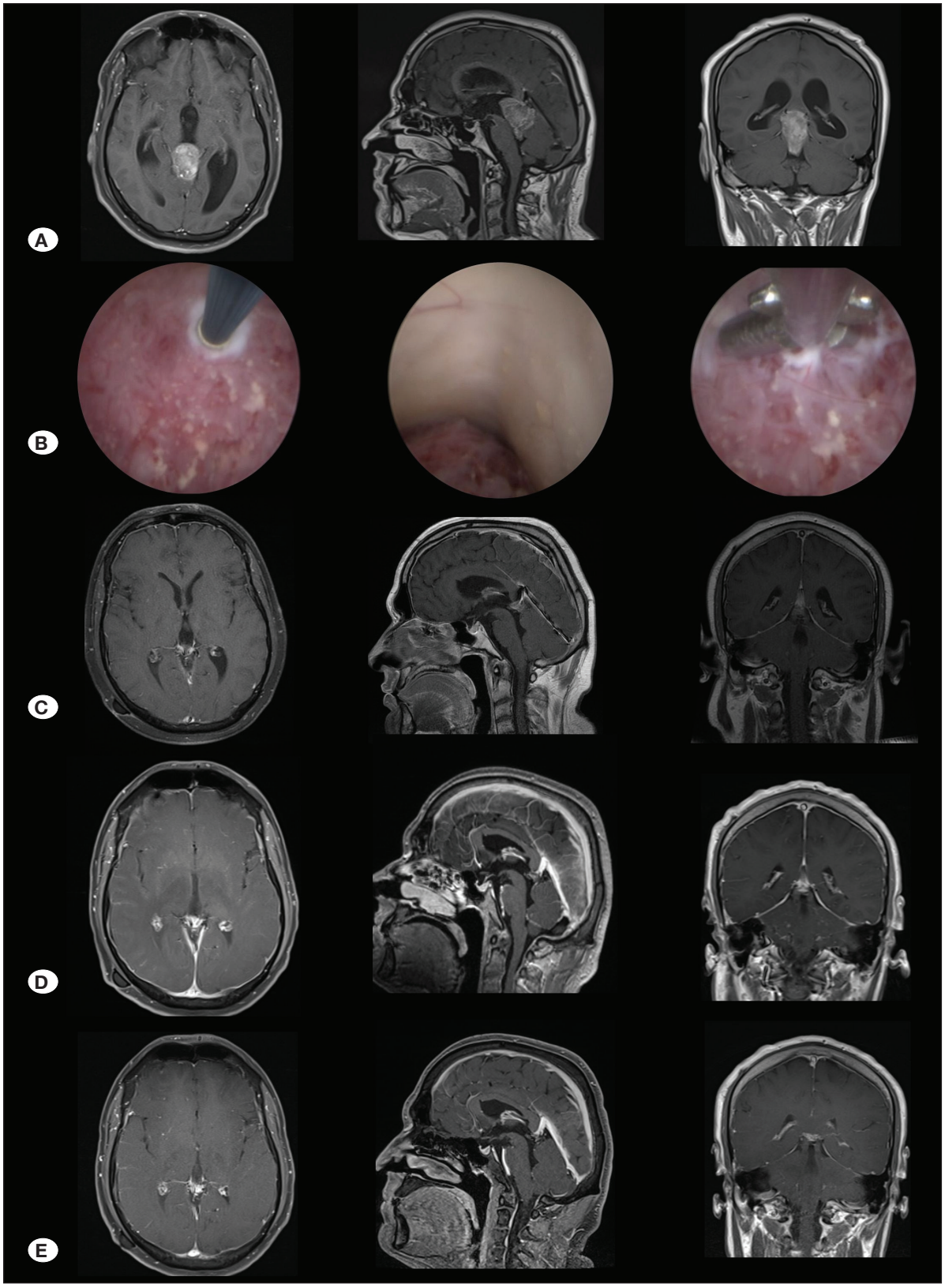

Figure 2: Sagittal, coronal, and axial gadolinium-enhanced T1-weighted magnetic resonance images (MRIs) showing a pineal lesion (Germinoma). **A)** Preoperative MRI. **B)** Intraoperative images during ETV, tumour exploration and biopsy, respectively. **C)** Early postoperative MRI after intensity-modulated radiation therapy and tomotherapy as well as 3 cycles of bleomycin, etoposide, and cisplatin treatment. **D)** Twelve-month follow-up MRI after VP shunt placement. **E)** Thirty-six-month follow-up MRI.

Because of the proximity of the pineal region to the ventricular system, lesions in such areas are highly likely to cause obstructive triventricular hydrocephalus. As lots of lesions do not need a total excision, diverting the cerebrospinal fluid might be considered as the initial issue to stabilize the patient's clinical status. It is reported around 50% of the patients with pineal region gliomas to undergo preliminary shunt for the treatment of hydrocephalus and also observed an average of two additional shunt-related procedures per patient in such population (5). Because ETV or septostomy can be performed simultaneously with biopsy, surgeons can use neuroendoscopy for both purposes (12,16). In a study, it is reported that ETV to be the treatment of choice for pineal region tumours, especially those in the posterior aspect of the third ventricle (11). In another study, an increased rate of success were reported when ETV was used in evaluating pineal region tumours (14). In our series, initial biopsy with endoscopy was the procedure of choice to guide further

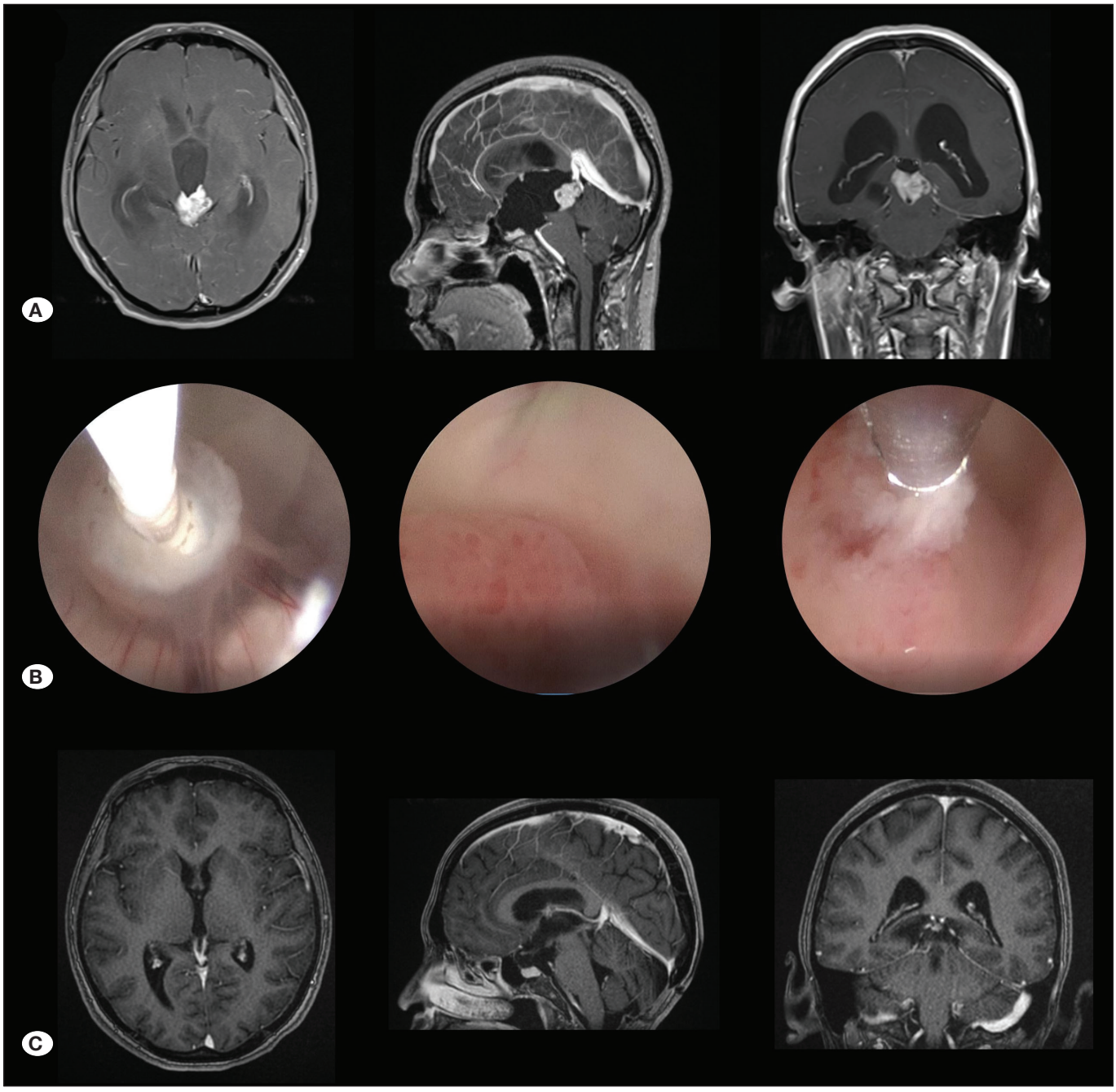

Figure 3: Sagittal, coronal, and axial gadolinium-enhanced T1-weighted magnetic resonance images (MRIs) showing a pineal lesion (Papillary tumour, Grade II). **A)** Preoperative MRI. **B)** Intraoperative images during ETV, tumour exploration and biopsy, respectively. **C)** After intensity-modulated radiation therapy; forty-nine-months follow-up MRI.

treatments. This may promote radiological stability or even regression of the lesions; decrease the shunt dependency when compared with stereotactic biopsy; and result in stable or better clinical status, which shows the superiority of using neuroendoscopy among diagnostic methods for pineal region as well as among treatment modalities for both the lesions and hydrocephalus.

As a limitation of this study, it is worth pointing out that our total number of sample size is seventeen, which is not sufficient to draw a conclusion. However, this study shows concrete evidences indicating further studies with a bigger sample size might be much suitable and powerful for generalizability along with strong indications for the use of neuroendoscopy. As this study is retrospective in nature, it should be indicated that retrospection is another limitation.

CONCLUSION

Lesions of the pineal region are challenging cases for which treatment must be meticulously planned. Neuroendoscopic biopsy is a relatively safe, effective, low-cost initial procedure with low morbidity rates and enables patients to resume daily life. Neuroendoscopy is the most favorable approach for simultaneously providing tissue sampling and diversion of cerebrospinal fluid via ETV in hydrocephalic patients with tumours in pineal region tumours. Neuroendoscopic approach also decreases shunt dependency in such cases.

Declarations

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Availability of data and materials: The datasets generated and/or analyzed during the current study are available from the corresponding author by reasonable request.

Disclosure: All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee (name of institute/committee) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

AUTHORSHIP CONTRIBUTION

Study conception and design: EB, HAE

Data collection: EB, OMO, EP, SU

Analysis and interpretation of results: EB, OO, MB

Draft manuscript preparation: EB, HAE, OMO

Critical revision of the article: EB, GK

Other (study supervision, fundings, materials, etc...):

All authors (OO, EB, HAE, OMO, SU, EP, MB, GK)) reviewed the results and approved the final version of the manuscript.

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