

Is surgery for pineal cysts safe and effective? Short review

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Abstract In this short review, the authors performed a database search and summarize current knowledge of the management of patients with pineal cysts (PCs) and investigate the role of surgical treatment. The scientific literature on the surgical treatment of PCs is sparse and encompasses only case series with little over 200 operated patients combined. All included papers reported favorable results after pineal cyst surgery with improvement of symptoms in most patients. Microsurgical resection of PCs, preferably using the supracerebellar-infratentorial approach, could be considered as a viable treatment option in symptomatic patients. Even patients with non-specific symptoms are reported to improve after surgery. However, evidence offered by this literature review is very limited and therefore our conclusions must be tempered by the restricted set of data. For ethical reasons, a randomized controlled trial is not an acceptable approach, and therefore patient registry could be a useful tool to identify a subset of symptomatic patients that might benefit from pineal cyst resection.

Keywords Pineal cyst · Hydrocephalus · Headache · Neurosurgery · Stereotactic biopsy · Neuroendoscopy

Introduction

Patients with a pineal cyst (PC) are increasingly referred to neurosurgeons and neurologists because of a widespread

availability of magnetic resonance (MR) diagnostics. Patients frequently present with non-specific symptoms and rarely with hydrocephalus or Parinaud's syndrome. Whereas patients with hydrocephalus and Parinaud's syndrome are clearly indicated for surgery, most patients with non-specific symptoms are managed conservatively. Occasionally, some neurosurgeons indicate patients with severe non-specific symptoms for surgical treatment, although it is not widely accepted in the neurosurgical community [13]. The first documented report of PC resection in the literature is from Pussep in 1914 [18]. Since then, several hundreds other cases have been reported, typically as case reports or as small retrospective studies. Large, prospective studies are lacking. Indication criteria for surgical treatment are vague in cases of non-specific symptoms and sometimes are based on the gut feeling of the surgeon rather than on objective criteria.

In this short review, we summarize current knowledge of the management of patients with pineal cysts and investigate the role of surgical treatment.

Material and methods

The PUBMED database was searched for publications using the terms “pineal cyst” and “pineal gland cyst” on June 8, 2017. Searches were restricted to the English language and human studies but without limitation on the publication date. The present authors checked and selected all articles according to the inclusion criteria described below. References in each included study were checked to find additional relevant studies. We included studies that fulfilled the following criteria:

- Case series with more than eight patients that underwent surgery for PC
- Case series of adult patients

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The exclusion criteria were the following:

- Only cerebrospinal fluid shunting surgery
- Insufficient clinical data

For each study, we determined the number of operated patients, PC size, surgical approach, length of follow-up, surgical complication, clinical outcome, and recurrence rate.

Results

Our search found 323 papers. After selection and cross-reference checking, ten studies matched our inclusion criteria [3, 6–11, 14, 17, 22]. Nine of the ten studies used a retrospective study design and one a prospective design [14]. Papers that were not included were case reports (37 papers), radiological studies (61 papers), surgical series of less than eight patients with PCs (11 papers), pediatric studies (34 papers), and others (170 papers).

The ten included studies comprised 211 patients who underwent surgery for PCs (Table 1). Cyst size ranged from 7 to 35 mm. Surgical procedures that were performed included microsurgical supracerebellar infratentorial and occipital transtentorial PC resection, microsurgical and endoscopic PC fenestration and stereotactic aspiration, and biopsy. Improvement in presenting symptoms occurred in 42.9–100% of the patients. The complication rate varied widely, from as low as 0.0% to as high as 77.8%.

None of the studies included a control group of patients with PCs that would be treated conservatively.

Discussion

Rationale for surgical treatment

In general, surgical treatment is reserved for patients with symptomatic pineal cysts. Surgery might also be considered in atypical cases in which the histological diagnosis is uncertain. “Typical” MR appearance of a PC is a smooth-walled cystic lesion in the pineal region with rim enhancement after gadolinium not thicker than 2 mm [2]. However, cases of multilobular PCs or heterogeneous contrast enhancement may arouse suspicion of a tumor. Watchful waiting with serial MR is one of the treatment strategies. Yet, definitive diagnosis of a PC can be based on only a histological tissue examination and therefore surgery might be justified. Several cases have been described in the literature in which pineal tumor was misdiagnosed as PCs [16, 21].

Which patient with PC is symptomatic?

In the era of widespread availability of MR imaging, patients with non-specific symptoms or unrelated symptoms often undergo brain scanning; in some of these patients PC is discovered. In most of these patients, PCs are merely an incidental finding and they should be assured of the benign nature of the PC. However, in some patients, PC might play a role in the pathogenesis of clinical symptoms and defining this subgroup of patients is therefore of paramount importance.

A classical textbook presentation of pineal lesions should be hydrocephalus and Parinaud’s syndrome, which is explained by direct pressure of the pineal mass on the mesencephalon. Nevertheless, PCs rarely grow large enough to compress surrounding structures and cause these symptoms. Hajnsek et al. did not diagnose hydrocephalus or Parinaud’s syndrome in a series of 56 patients [9] and Majovsky et al. reported only one patient in series of 21 patients [14]. On the other hand, Berhouma et al. reported obstructive hydrocephalus in 18 (75%) of 24 operated patients [3]. These results are most likely subject to selection bias and probably caused by different indication criteria employed in different departments.

Nonspecific symptoms seen in patients with PCs may include headache, vertigo, nausea, fatigue, diplopia, tremor, seizures, and paresthesia. Seifert et al. studied the association between PC and headache. These authors compared 51 patients with PC and 51 matched controls without PC [20]. Patients with PC had headaches twice as often as the controls, suggesting the existence of causality. The exact mechanism remains unknown, although several hypotheses have been proposed (e.g., a melatonin disturbance or compression of the vein of Galen) [4, 5].

Is surgery effective?

The present research has shown clinical improvement ranging from as low as 42.9% to as high as 100%. However, more recent studies have shown a clinical improvement of over 90%. Unfortunately, five of the ten studies in our review do not specifically address clinical outcome. Measuring the outcome is very heterogenic: some authors simply state, “symptoms were resolved” [9–11] and others created their own ad hoc scales [6]. In our series, we employed a standardized validated questionnaire designed to measure outcome after surgery for Chiari malformation (Chicago Chiari Outcome Scale) [1]. Today, there is a need to develop a specific outcome measuring tool in patients with PCs.

Improvement in symptoms of increased intracerebral pressure due to hydrocephalus or oculomotor palsy caused by the direct compression of mesencephalon is expected when the mass effect of PC is removed. Nevertheless, most patients in the reviewed series presented with non-specific symptoms and yet high improvement was achieved. Even an unusual, rare

Table 1 Included studies on surgery for PCs

Authors	Year of publication	Number of patients	Average size of cyst (mm)	Surgical approach (no. of cases)				Mean follow-up (patient-months)	Complication rate (%)	Improvement of symptoms (%)	Recurrence (%)
				SCIT ^a	OTT ^b	Stereo-biopsy	Microsurgical fenestration				
Fettel et al.	1991	9	16	9	0	0	0	n/a	0.0	66.7	0.0
Faim et al.	1994	24	17	23	0	1	0	n/a	12.5	n/a	n/a
Kreth et al.	1996	14	n/a	0	0	14	0	48.0	0.0	42.9	n/a
Mena et al.	1997	15	17	13	1	1	0	79.2	13.3	n/a	6.7 ^c
Tirakotai et al.	2004	9	n/a	0	0	0	0	n/a	0.0	n/a	11.1
Hajnssek et al.	2013	56	n/a	56	0	0	0	n/a	0.0	100.0	n/a
Kalani et al.	2015	18	15	n/a	n/a	0	0	19.2	77.8	94.4	0.0
Berhouma et al.	2015	24	n/a	0	20	0	0	144.0	25.0	n/a	0.0
Eide and Ringstad	2017	21	17	n/a	n/a	0	6	46.1	0.0	90.5	0.0
Majovsky et al.	2017	21	19	21	0	0	0	71.2	9.5	95.2	0.0

^a Supracerebellar infratentorial approach^b Occipital transtentorial approach^c One pineal cyst recurred in one patient after stereotactic biopsy

presentation of PC (such as seizures, monoparesis, face numbness, tremor, ataxia, hemiparesis, or syncope) could resolve after cyst resection. The exact mechanism of relief of non-specific symptoms is not easily explained by PC resection; instead, some might argue for the suspicion of a placebo effect [12]. However, we regard a placebo effect as a less plausible explanation because of a relatively high symptom improvement rate and because of the long-lasting effect of the surgery.

What type of surgery?

If surgical treatment of PCs were considered, modern neurosurgery offers microsurgery, endoscopy, and stereotaxy in its armamentarium. Two main microsurgical approaches are a supracerebellar infratentorial and an occipital transtentorial approach to the pineal region. A stereotactic approach enables puncture and an aspiration of the PC and may serve as a biopsy as well. An endoscopic route towards the PC is transtentorial and allows the treating of a hydrocephalus by performing a third ventriculostomy.

Microsurgery

In most cases, the goal of surgery is PC resection (Fig. 1), which is achieved microsurgically either by a supracerebellar infratentorial (SCIT) or an occipital transtentorial approach (OTT). The SCIT approach is a straightforward extracerebral technique via the natural corridor between the superior aspect of the cerebellum and the tentorium (Fig. 2). Preferably, the unilateral SCIT approach is used to protect a dominant transverse sinus and spare some bridging veins between the cerebellum and the tentorium that are in the surgical corridor. A radical pineal cyst resection is achieved in almost all cases. Possible complications include diplopia and venous infarction of the cerebellum. In the largest surgical series, all patients underwent surgery using the SCIT approach in a sitting position. In this patient group, the complication rate was 0% [9].

Fig. 1 Sagittal T2-weighted MR scan of patient with a pineal cyst before (a) and after a cyst resection (b)

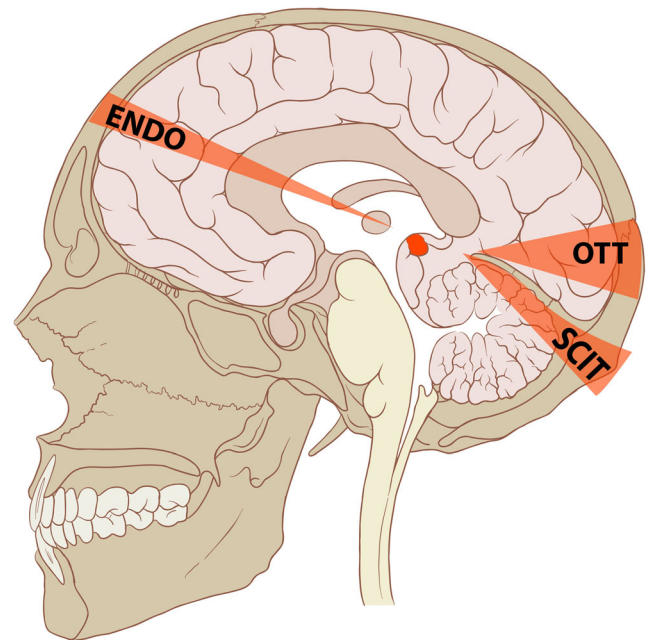
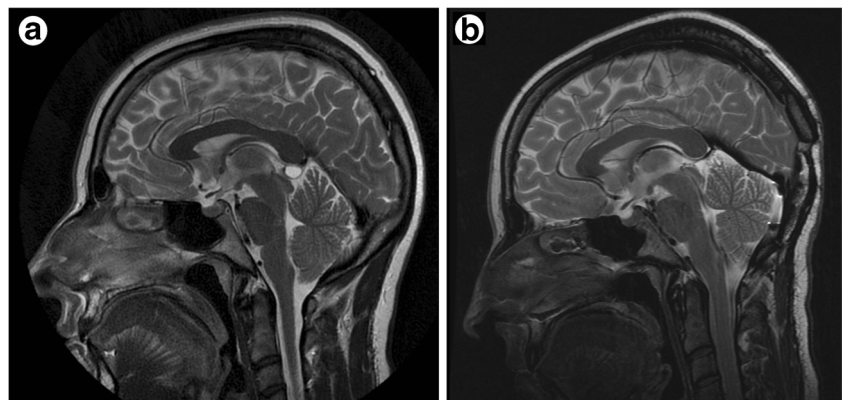


Fig. 2 Schematic depiction of surgical approaches to a pineal cyst. Supracerebellar-infratentorial approach (SCIT), occipital-transtentorial approach (OTT), and transventricular endoscopic approach (ENDO). Adapted from “Skull and brain sagittal” by Patrick J. Lynch and C. Carl Jaffe; used under CC BY 2.5

Another common microsurgical approach is OTT, which is also extracerebral, but in contrast to SCIT, the pineal region is accessed supratentorially along the falcotentorial angle (Fig. 2). A slight retraction to the occipital lobe and incision of the tentorial apex are necessary to create a surgical corridor towards the PC. The most common complication after OTT is hemianopia, which occurs transiently in 16.1–79% of the patients and permanently in 0–4.1% [3, 19, 23]. Berhouma et al. used OTT in 20 patients with PC and achieved radical resection in 70% with a complication rate of 20% (four patients with transient hemianopia) [3]. Because of the relatively high prevalence of postoperative hemianopia with the OTT approach, we exclusively use SCIT for PC resection. It is surprising that recent series on pineal cysts resection report rather a high complication rate [3, 10].

Microsurgery shows the highest rate of clinical improvement, with more than 90% showing improvement [6, 9, 10, 14]. Eide et al. reported on 21 operated patients: 15 had their PC resected and six had their PC microscopically fenestrated. The authors found significantly better results in the resection group [6]. In our series of patients with PC resection, we spared some pineal tissue (less than half of the PC) to prevent total melatonin secretion loss [14]. Despite this sparing strategy, we still achieved improvement in 95.2% of our patients. These results suggest superiority of total or near-total PC resection over fenestration.

The matter of physiological changes after radical PC resection is not yet fully resolved. In our previous study, we examined melatonin and cortisol secretion profiles in four patients before and after PC resection. In all cases, patients experienced a loss of endogenous pineal melatonin production, which equated with pinealectomy. Surprisingly, cortisol secretion substantially increased in patients after surgery. Presently, we do not have an explanation for that finding [15].

Stereotaxy

Kreth et al. reported the largest case series using stereotactic aspiration of PCs ($n = 14$ patients). The authors encountered no complications, but clinical improvement was achieved in only 42.9% of the patients. No recurrence was noted in this series, although Mena et al. reported the regrowth of a PC in their series with only one patient treated with stereotactic aspiration [17].

Endoscopy

An advent of neuroendoscopy has resulted in the introduction of new techniques for pineal region surgery that allowed the surgeon to address both PC and coexisting hydrocephalus (Fig. 2). However, the complete removal of a PC is usually not possible. Tirakotai et al. performed an endoscopic fenestration and biopsy in nine patients. No complications occurred in this series but one PC recurred. Regrettably, the authors do not state the clinical outcome of the patients.

Study limitations

Our paper has two main limitations that need to be addressed. First, all ten studies in this review are case studies, which represent only a level of evidence 4 according to the Oxford Centre for Evidence-based Medicine. Second, a potential publication bias might have manifested itself in the present review. Publication bias occurs when studies with positive findings are more likely to be published than studies with negative findings, which can distort the perception of a topic by the medical community. Because of such bias, reports showing

infectivity of pineal cyst resection might have never reached the scientific literature.

Conclusion

The scientific literature on the surgical treatment of PCs is sparse and encompasses only case series with little over 200 operated patients combined. All included papers reported favorable results after pineal cyst surgery with improvement of symptoms in most patients. Microsurgical resection of PCs, preferably using the supracerebellar-infratentorial approach, could be considered as a viable treatment option in symptomatic patients. Even patients with non-specific symptoms are reported to improve after surgery. However, evidence offered by this literature review is very limited, and therefore our conclusions must be tempered by the restricted set of data. For ethical reasons, a randomized controlled trial is not an acceptable approach, and therefore patient registry could be a useful tool to identify a subset of symptomatic patients that might benefit from pineal cyst resection.

Compliance with ethical standards

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Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent For this type of study formal consent is not required.

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