Different Surgical Options for the Management of Symptomatic Intracranial Arachnoid Cysts: A Systematic Review

Review Article

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ABSTRACT

Background: Arachnoid cysts are non-neoplastic, intracranial cerebrospinal fluid CSF-filled spaces lined with arachnoid membranes. Small arachnoid cysts are mostly asymptomatic and may warrant watchful waiting and serial imaging follow-up. However, large arachnoid cysts are often symptomatic because they compress surrounding structures causing increased intracranial tension, fits, behavioral changes or visual hallucinations according to its site/size, therefore, they must be treated surgically. As several surgical management options exist, the best approach should be chosen according to each type of arachnoid cyst. Ongoing research aims to enhance our understanding of the clinical characteristics of these lesions, refine diagnostic approaches, and optimize treatment strategies to improve outcomes and quality of life for affected individuals.

Objective: The objective of this study is to compare between different surgical approaches in treatment of symptomatic intracranial arachnoid cysts mainly microscopic fenestration, endoscopic fenestration & cystoperitoneal shunt in terms of short and long-term effectiveness and complications in different types of arachnoid cysts.

Data Sources: Medline databases (PubMed, Medscape, EMBASE, ScienceDirect, Cochrane database of systematic reviews) and all materials available in the Internet till 2024.

Data Extraction: If the studies did not fulfill the inclusion criteria, they were excluded. Study quality assessment included whether ethical approval was gained, eligibility criteria specified, appropriate controls, and adequate information and defined assessment measures.

Conclusion: Our data showed that all three surgical methods are effective treatments in terms of clinical improvement with no statistically significant difference among them, however, microsurgical fenestration is favored over CP shunt with statistically significant difference. Microsurgical fenestration was followed by the highest incidence of postoperative cyst volume reduction (86.2%) with statistically significant difference. On the other hand, endoscopic fenestration was accompanied by the lowest rate of recurrence (19%) with statistically significant difference. The three modalities showed statistically non-significant difference in terms of post-operative short-term complications and permanent neurological deficits.

Further prospective randomized controlled trials are recommended to evaluate the surgical options, using clear and explicit criteria for inclusion, objective outcome definitions and assessment, and ensuring a consistent long follow-up to minimize the uncertainty in some data such as long-term complications and incidence of permanent deficits.

Key Words: Arachnoid, cystoperitoneal, endoscopy, fenestration, hemorrhage, intracranial, intracystic, microscopic, shunt.

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INTRODUCTION

Arachnoid cysts (ACs) are considered congenital, non-neoplastic, extra-axial, cerebrospinal fluid (CSF)-filled intra-arachnoid lesions. They are the commonest intracranial cysts and represent 1% of intracranial lesions. The natural history of most ACs is benign and they are usually asymptomatic. But, ACs are dynamic entities as they may fluctuate in size. The clinical course of arachnoid cysts is still unpredictable in most cases. Asymptomatic cases are typically managed through observation and periodic imaging to ensure stability. Symptomatic intracranial arachnoid cysts present a complex clinical scenario. The spectrum of symptoms can range from mild headaches to severe neurological deficits, including seizures, cognitive decline, motor impairments, neuroendocrine disorders and visual defects. With Headache being the most common presenting complaint[1,2].

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Arachnoid cysts may be seen in different locations intracranial, most are supratentorial and located in the temporal fossa. The remainder may occur in the cerebellopontine angle, suprasellar and quadrigeminal cisterns, cerebral convexity, and cisterna magna[1,2].

In most of the cases, intracranial arachnoid cysts are accidentally discovered, when brain imaging is done for another purpose as in case of head trauma. Brain computed tomography (CT) is often enough to diagnose an arachnoid cyst. However, magnetic resonance imaging (MRI) brain is superior as it assess the exact location, size and relation of the arachnoid cyst to the surrounding structure and to plan for surgery.

Surgical approaches for management IACs vary and include: microsurgical fenestration, endoscopic fenestration, CP shunt and stereotactic aspiration. Fenestration procedures aim to drain the cyst contents into the nearby basal cisterns or the ventricles by opening of the cyst membrane. CP shunt aims to drain the cyst contents into the peritoneal cavity. External drainage of the cyst outside the body can be achieved through stereotactic aspiration.

Many factors influence choosing the appropriate surgical procedure, including age, size, site of the cyst. Also, risk associated with the intervention and surgeon experience also affect the decision. Owing to the varied presentation and different forms of ACs, as well as their unclear natural course, deciding on the optimal method for treatment is still controversial.

AIM OF THE WORK

To compare between different surgical approaches in treatment of symptomatic intracranial arachnoid cysts mainly microscopic fenestration, endoscopic fenestration & cystoperitoneal shunt in terms of short and long-term effectiveness and complications in different types of arachnoid cysts.

PATIENTS AND METHODS

In the current review, we aim to analyse the collective data from studies comparing different surgical approaches in treatment of symptomatic intracranial arachnoid cysts mainly microscopic fenestration, endoscopic fenestration & cystoperitoneal shunt.

Primary objective is to compare between the three groups in terms of symptomatic improvement, cyst volume reduction in radiology and post-operative short-term complications.

Secondary objective is to evaluate the rate of permanent neurological deficits and recurrence among the three groups.

Search strategy and analysis

The following electronic databases were searched for included articles in English language: PubMed, EMBASE, Cochrane database of systematic reviews.: using the keywords “intracranial-arachnoid- microscopic-cystoperitoneal- shunt- intracystic- hemorrhage-fenestration- endoscopy” in different combinations. Also, manual search was conducted for reference lists of included articles.

The information sources previously mentioned were searched from January 1, 2000 to September 1, 2024.

Types of studies:

All available studies from January 1, 2000 to September 1, 2024 including randomized or non-randomized clinical trials, prospective or retrospective observational cohort studies, and case series of 6 or more cases that address these criteria were collected.

The following articles were excluded: duplicate articles, unavailable full texts, or abstract-only articles as proceeding papers, conference, editorial, and author response. Non primary articles (e.g. reviews) were excluded but their reference lists were manually searched for possible additional primary articles.

The search yield passed several phases of filtration to come up with the most relevant publications. First, studies containing the target keywords in title or abstract were examined, duplicates were removed, and studies with inappropriate study type or irrelevant title were excluded, yielding 50 studies.

Out of these, the studies meeting our inclusion criteria were considered eligible. Then the authors examined

the selected papers for whether desired outcomes were measured with appropriate follow-up periods.

Exclusion criteria included abstracts and case reports, studies that were done on animals, and those including patients lost before the minimal follow-up period.

Subsequently the full text of the articles was reviewed to exclude texts not fulfilling the criteria or deviating from the first impression taken from the title/abstract. References/bibliography of the selected articles were examined for possible further research and possible inclusion in the analysis. Any differences were sort out by consensus between study team.

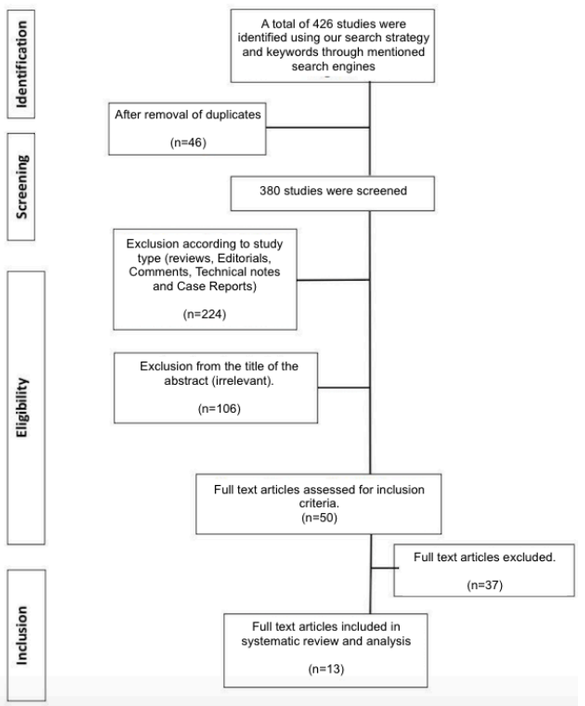

Fig. 1: PRISMA Schematic Research Strategy Flowchart for included studies in the review.

Statistical Analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version(23). The quantitative data were presented as mean and standard deviations. Also, qualitative variables were presented as number and percentages. The comparison between groups with qualitative data were done using Chi-square test. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the *P-value* was considered significant as the following: $P>0.05$: Nonsignificant (NS). $P<0.05$: Significant. $P<0.01$: Highly significant (HS).

RESULTS

Literature search

A total of 426 citations were identified. Search was done for studies conducted or published within January 1, 2000 to September 1, 2024 duration. 46 duplicate studies were removed, the titles of 380 articles were eligible, with exclusion of non-appropriate study design. This yielded 156 studies, 106 were excluded from the abstract and 50 studies that underwent full-text analysis, of which 37 did not meet the inclusion criteria for having asymptomatic patients, patients who underwent conservative management or patients lost before the minimal follow-up period.

Thirteen studies were included in our systematic review for analysis of demographics and the outcome of different surgical options focusing on clinical improvement and postoperative complications. Ten observational retrospective studies with data gathered from previously documented records and imaging, and three studies were prospective. Due to searching within heterogeneous group of studies with different measures.

Studies Description and Demographic characteristics

Thirteen studies were included in our systematic review. Seven studies compared the three surgical options, four studies were performed using endoscopic fenestration only and two studies were performed using microscopic fenestration only.

Three studies were prospective studies, while ten were observational retrospective studies with data gathered from previously documented records and imaging.

Three studies were performed in USA, and one study was performed in each of the following: UK, Germany, France, Denmark, Turkey, Egypt, Italy, China, Jordan and Morocco.

Characteristics of included studies

Participants

A total of 667 participants were involved in the included studies, comprising 318 patients who underwent microscopic fenestration, 268 underwent endoscopic fenestration and 81 underwent cystoperitoneal shunting. The mean age of patients is 17.7±13.7 years across the 13 studies (Table.1).

Table 1: Mean age of the patients included the reviewed studies.

Author, year, country	Study Design	No. of patients	Mean age of the patients (years)
Hall et al., 2019[3], UK	ROS	82	27.8 ± 25.5
Khan et al., 2013[4], USA	ROS	45	36.2 ± 19.9
Amelot et al., 2019[5], France	ROS	142	6.4
Elghandour et al., 2012[6], Egypt	POS	32	3.6
Spacca et al., 2009[7], Italy	ROS	40	7.8
El Damaty et.al 2023[8], Germany	ROS	61	5.6
Boutarbouch et al., 2007[9], Morocco	ROS	20	27
Levy et al., 2003[10], USA	ROS	50	5.7□ ± 4.8
Xu et al., 2016[11], China	POS	26	21.3
Greenfield et al., 2005[12], USA	POS	33	16.8
Kirmizigoz et al., 2022[13], Turkey	ROS	60	19.38 ±1.76
Tamimi et al., 2021[14], Jordan	ROS	20	15.2±16.7
Holst et al., 2012[15], Denmark	ROS	56	37.5
Total		667	17.7±13.7

Location of arachnoid cysts varies across the included studies; 467 in the middle fossa (70%), 88 in the posterior fossa (13.2%), 32 at the convexity (4.8%), 26 at the sellar-suprasellar region (3.9%), 16 inter-hemispheric (2.4%), 15 quadrigeminal (2.2%) and the remaining 23 were found at other regions. (Table.2)

Table 2: Locations of arachnoid cysts across the included studies.

	Middle fossa	Post. Fossa	Convexity	Supra-sellar	Inter-hemispheric	Quadrigeminal	Other	
Hall et al., 2019	25	21	11	10	1	9	2	
Khan et al., 2013	13	22		2				
Amelot et al., 2019	142							
Elghandour et al., 2012	32							
Spacca et al., 2009	40							
El Damaty et al., 2023	31	10		4	12		4	
Boutarbouch et al., 2007	10	8	7	1	1	3	2	
Levy et al., 2003	50							
Xu et al., 2016	26							
Greenfield et al., 2005	3			7	2	1	9	
Kirmizigoz et al., 2022	44	10	6				6	
Tamimi et al., 2021	11	3		1				
Holst et al., 2012	40	14	8	1		2		
Total (%)	467 (70%)	88 (13.2%)	32 (4.8%)	26 (3.9%)	16 (2.4%)	15 (2.2%)	23 (3.5%)	667 (100%)

Interventions:

Surgical interventions included microscopic fenestration, endoscopic fenestration and cystoperitoneal shunting. Out of the included 13 studies, microscopic fenestration was performed in 9 of them (*n*=318), endoscopic fenestration was performed in 11 (*n*=268) and CP shunt was performed in 7 (*n*=81).

Outcome measures:

1. Clinical improvement

From the 13 included studies, 11 studies reported improvement of clinical symptoms after the surgical intervention. This permitted data extraction and comparison between the 3 surgical groups. Those 11 studies included a total of 506 patients and reported clinical improvement in 438 of them (86.6%). Out of 222 patients operated for microsurgical fenestration, clinical improvement was reported in 199 (89.6%). 231 patients were operated for endoscopic fenestration, with reported clinical improvement in 198 (85.7%). 53 patients were operated for CP shunt, with reported clinical improvement in 41 (77.4%). There was no statistically significant difference within the percentage of clinical improvement among the three surgical groups with *P-value* 0.055 (NS). However, statistically significant difference is seen on comparing between microsurgical fenestration and CP shunt groups with *P-value* 0.016 (S), favoring microsurgical fenestration over CP shunt.

Table 3: Comparison between microsurgical fenestration, endoscopic fenestration and CP shunt regarding percentage of post-operative clinical improvement.

clinical improvement	Microsurgical fenestration			Endoscopic fenestration			CP shunt		
	Total no.	No.	%	Total no.	No.	%	Total no.	No.	%
Hall et al., 2019[3]	34	28	82.4%	45	35	77.8%	3	3	100.0%
Amelot et al., 2019[5]	68	58	85.3%	35	26	74.3%	39	27	69.2%
Elghandour et al., 2012[6]	-	-	-	32	28	87.5%	-	-	-
Spacca et al., 2009[7]	-	-	-	40	37	92.5%			
El Damaty et al., 2023[8]	33	32	97.0%	18	16	88.9%	10	10	100.0%
Boutarbouch et al., 2007[9]	17	13	76.5%	2	2	100.0%	1	1	100.0%
Levy et al., 2003[10]	50	48	96.0%	-	-	-	-	-	-
Xu et al., 2016[11]	-	-	-	26	22	84.6%	-	-	-
Greenfield et al., 2005[12]	-	-	-	33	32	97.0%	-	-	-
Kirmizigoz et al., 2022[13]	-	-	-	-	-	-	-	-	-
Tamimi et al., 2021[14]	20	20	100.0%	-	-	-	-	-	-
Total	222	199	89.6%	231	198	85.7%	53	41	77.4%
Chi-square test					5.810				
P-value					0.055 (NS)				
				Multiple comparison					
Microsurgical fenestration Vs Endoscopic fenestration				Microsurgical fenestration Vs CP shunt			Endoscopic fenestration Vs CP shunt		
0.204				0.016			0.133		

P-value >0.05: Non significant (NS); *P-value* <0.05: Significant (S); *P-value*< 0.01: highly significant (HS)

The previous table shows that no statistically significant difference within the percentage of clinical improvement between the three surgical groups with *P-value* 0.055 (NS). However, statistically significant difference is seen on comparing between microsurgical fenestration and CP shunt groups with *P-value* 0.016 (S), favoring microsurgical fenestration over CP shunt.

2. Radiological cyst volume reduction

Out of the 13 included studies, 8 studies commented on the post-operative cyst volume reduction in radiology. Across these papers, 188 patients operated for microscopic fenestration, cyst volume reduction was seen in 162 (86.2%). 153 patients were operated for endoscopic fenestration, with reported cyst volume reduction in 115 (75.2%). CP shunt was performed in 50 patients with reported cyst volume reduction in 43 (86%). There was statistically significant difference with *P-value* 0.023 (S) among the three groups in terms of postoperative radiological cyst volume reduction. A statistically significant difference was observed on comparing microscopic and endoscopic fenestration with *P-value* 0.01 (S).

Table 4: Comparison between microsurgical fenestration, endoscopic fenestration and CP shunt regarding percentage of post-operative radiological cyst volume reduction.

cyst volume reduction	Microsurgical fenestration			Endoscopic fenestration			CP shunt		
	Total no.	No.	%	Total no.	No.	%	Total no.	No.	%
Amelot et al., 2019[5]	68	62	91.2%	35	28	80.0%	39	33	84.6%
Elghandour et al., 2012[6]	-	-	-	32	23	71.9%	-	-	-
Spacca et al., 2009[7]	-	-	-	40	24	60.0%	-	-	-
El Damaty et al., 2023[8]	33	26	78.8%	18	16	88.9%	10	9	90.0%
Boutarbouch et al., 2007[9]	17	14	82.4%	2	0	0.0%	1	1	100.0%
Levy et al., 2003[10]	50	41	82.0%	-	-	-	-	-	-
Xu et al., 2016[11]	-	-	-	26	24	92.3%	-	-	-
Tamimi et al., 2021[14]	20	19	95.0%	-	-	-	-	-	-
Total	188	162	86.2%	153	115	75.2%	50	43	86.0%
Chi-square test				7.544					
P-value				0.023 (S)					
Multiple comparison									
Microsurgical fenestration Vs Endoscopic fenestration				Microsurgical fenestration Vs CP shunt			Endoscopic fenestration Vs CP shunt		
0.010				0.975			0.109		

P-value >0.05: Non significant (NS); *P-value* <0.05: Significant (S); *P-value*< 0.01: highly significant (HS)

The previous table shows statistically significant difference with *P-value* 0.023 (S) among the three groups in terms of postoperative radiological cyst volume reduction. A statistically significant difference was found on comparing microscopic and endoscopic fenestration with *P-value* 0.01 (S).

3. Short-term complications

Out of the 13 included studies, 7 studies reported the rate of postoperative short-term complications including bleeding, hygroma, cranial nerves palsy, CSF leak and meningitis. Those studies included a total of 308 patients, and complications occurred in 74 of them (24%). Within the microsurgical fenestration group, complications were encountered in 40 out of 137 patients (29.2%), while in the endoscopic fenestration group, complications occurred in 34 out of 161 patients (21.1%). No complications were encountered in the CP shunt group in the single study that commented on post-operative complications after CP shunt14. No statistically significant difference was found among the three groups with *P-value* 0.124 (NS).

Table 5: Comparison between microsurgical fenestration, endoscopic fenestration and CP shunt regarding percentage of post-operative short-term complications.

Complications	Microsurgical fenestration			Endoscopic fenestration			CP shunt		
	Total no.	No.	%	Total no.	No.	%	Total no.	No.	%
Hall et al., 2019[3]	34	4	11.8%	45	8	17.8%	-	-	-
Elghandour et al., 2012[6]	-	-	-	32	3	9.4%	-	-	-
Spacca et al., 2009[7]	-	-	-	40	16	40.0%	-	-	-
El Damaty et al., 2023[8]	33	7	21.2%	18	3	16.7%	10	0	0.0%
Levy et al., 2003[10]	50	20	40.0%	-	-	-	-	-	-
Xu et al., 2016[11]	-	-	-	26	4	15.4%	-	-	
Tamimi et al., 2021[14]	20	9	45.0%	-	-	-	-	-	-
Total	137	40	29.2%	161	34	21.1%	10	0	0.0%
Chi-square test	4.179								
P-value				0.124 (NS)					
Multiple comparison									
Microsurgical fenestration Vs Endoscopic fenestration				Microsurgical fenestration Vs CP shunt			Endoscopic fenestration Vs CP shunt		
0.294				0.063			0.104		

P-value >0.05: Non significant (NS); *P-value* <0.05: Significant (S); *P-value*< 0.01: highly significant (HS)

The previous table shows statistically nonsignificant difference among the three groups with *P-value* 0.124 (NS) in terms of postoperative complications.

4. Recurrence

Out of the 13 included studies, 5 studies commented on the rate of recurrence of clinical symptoms after surgical intervention within a follow-up period range of 3-9 years across these studies. They included a total of 201 patients, and reported recurrence in 53 of them (26.4%). Microsurgical fenestration group included 80 patients, recurrence occurred in 24 (30%). Endoscopic fenestration group included 100 patients, with reported recurrence in 19 (19%). The highest percentage of recurrence was seen in CP shunt group, where 10 out of 21 patients experienced recurrence (47.6%) with a statistically significant difference among the three groups with *P-value* 0.016 (S).

Table 6: Comparison between microsurgical fenestration, endoscopic fenestration and CP shunt regarding rate of recurrence.

Recurrence	Microsurgical fenestration			Endoscopic fenestration			CP shunt		
	Total no.	No.	%	Total no.	No.	%	Total no.	No.	%
Elghandour et al., 2012[6]	-	-	-	32	3	9.4%	-	-	-
El Damaty et al., 2023[8]	33	11	33.3%	18	3	16.7%	10	6	60.0%
Boutarbouch et al., 2007[9]	17	5	29.4%	2	1	50.0%	-	-	-
Greenfield et al., 2005[12]	-	-	-	33	1	3.0%	-	-	-
Holst et al., 2012[15]	30	8	26.7%	15	11	73.3%	11	4	36.4%
Total	80	24	30.0%	100	19	19.0%	21	10	47.6%
Chi-square test	8.224								
P-value	0.016 (S)								
Multiple comparison									
Microsurgical fenestration Vs Endoscopic fenestration	Microsurgical fenestration Vs CP shunt			Endoscopic fenestration Vs CP shunt					
0.085	0.128			0.005					

P-value >0.05: Non significant (NS); *P-value* <0.05: Significant (S); *P-value*< 0.01: highly significant (HS)

The previous table shows statistically significant difference among the three groups with *P-value* 0.016 (S) in terms of rate of recurrence.

5. Permanent neurological deficit

Out of the 13 included studies, 7 studies commented on incidence of permanent neurological deficit within a follow up period ranging from 6 months to 9 years across these studies. No permanent neurological deficit was encountered across them.

Table 7: Comparison between microsurgical fenestration, endoscopic fenestration and CP shunt regarding the percentage of permanent neurological deficit.

Permanent neurological deficit	Microsurgical fenestration			Endoscopic fenestration			CP shunt		
	Total no.	No.	%	Total no.	No.	%	Total no.	No.	%
Khan et al., 2013[4]	34	0	0.0%	5	0	0.0%	6	0	0.0%
Elghandour et al., 2012[6]	-	-	-	32	0	0.0%	-	-	-
Spacca et al., 2009[7]	-	-	-	40	0	0.0%	-	-	-
Levy et al., 2003[10]	50	0	0.0%	-	-	-	-	-	-
Xu et al., 2016[11]	-	-	-	26	0	0.0%	-	-	-
Greenfield et al., 2005[12]	-	-	-	33	0	0.0%	-	-	-
Tamimi et al., 2021[14]	20	0	0.0%	-	-	-	-	-	-
Total	104	0	0.0%	136	0	0.0%	6	0	0.0%
Chi-square test	NA								
P-value	NA								
Multiple comparison									
Microsurgical fenestration Vs Endoscopic fenestration	Microsurgical fenestration Vs CP shunt			Endoscopic fenestration Vs CP shunt					
NA	NA			NA					

P-value >0.05: Non significant (NS); *P-value* <0.05: Significant (S); *P-value*< 0.01: highly significant (HS).

The current data showed that the three surgical methods are efficient in terms of clinical improvement with no statistically significant difference among them. However, microsurgical fenestration is favored over CP shunt with statistically significant difference. Both microsurgical fenestration and CP shunt were followed by the high incidence of postoperative cyst volume reduction in comparison to endoscopic fenestration with statistically significant difference. On the other hand, endoscopic fenestration was accompanied by the lowest rate of recurrence (19%) with statistically significant difference. The three modalities showed statistically non-significant difference in terms of post-operative short-term complications and permanent neurological deficits.

DISCUSSION

Arachnoid cysts (ACs) are benign, congenital, non-neoplastic, extra-axial, cerebrospinal fluid (CSF) intra-arachnoid lesions. They are the commonest intracranial cysts and represent 1% of intracranial space-occupying lesions. usually most ACs are asymptomatic over time. However, ACs are not static entities as it may increase in size. Asymptomatic cases are typically managed through observation and periodic imaging to ensure stability.

Symptomatic intracranial arachnoid cysts present a complex clinical scenario. The spectrum of symptoms can range from mild headaches to severe neurological deficits, including seizures and motor impairments. Understanding the heterogeneity of these presentations is crucial for tailoring effective interventions.

Despite advancements in diagnostic tools and treatment modalities, challenges persist in predicting the clinical course of arachnoid cysts. Research efforts continue to unravel the underlying mechanisms and refine treatment algorithms.

Many factors influence choosing the appropriate surgical procedure, including age, size, site of the cyst. Also, risk associated with the intervention and surgeon experience also affect the decision. Owing to the varied presentation and different forms of ACs, as well as their unclear natural course, deciding on the optimal method for treatment is still controversial[16].

Therefore, different therapeutic approaches with different outcomes have been discussed in the literature that may not be straightforward in all patients with ACs[9]. Our study focused on the most popular three surgical modalities that are the most widely used nowadays, which are microsurgical cyst fenestration, endoscopic fenestration and cystoperitoneal shunting.

A meta-analysis of 474 patients demonstrated no significant difference in the rate of symptomatic improvement among the three procedures[17]. ***Gangemi et al.*** showed clinical improvement in 88% of patients treated by microsurgery, in 96.8% after cysto-peritoneal shunt, and in 70% with endoscopic fenestration[18]. Our data were similar to the previously mentioned literature in terms of rate of clinical improvement in each group, and the non-significant difference among the three surgical groups. Nevertheless, the current study showed statistically significant difference between microsurgical fenestration and shunt groups with *P-value* 0.016 (S), favoring microsurgical fenestration over CP shunt in terms of clinical improvement.

There is no solid evidence about the relationship between cyst size reduction and clinical improvement[5] ***Amelot et. al.,*** assumed that improvement of clinical and/or cognitive signs and the presence of a stream that is visible at the cystostomy level on MRI 3D T2-weighted sequences are the best markers of a successful treatment[5].

It is worth to be mentioned that most studies commented on cyst volume reduction as a yes/no variable, while others as ***Kirmizigoz et al.***,[13] commented on it in quantitative manner through calculating cyst volume change and cyst volume reduction rate. Moreover, most of the studies also didn't mention the timing of the post-operative imaging.

El Damaty et. al.,[8] reported symptomatic improvement in 95% of patients (58/61) and reduction of cyst size in 83.6% (51/61 patients) after surgery, indicating that clinical improvement may occur without significant reduction of cyst size radiologically assuming that the high intra-cystic pressure is the main drive for symptoms, not the cyst size.

Radiological regression of cyst size is accepted as a sign of radiological improvement. Although cystoperitoneal shunt is not associated with the highest rate of clinical improvement, the shunt procedure is associated with the high rate of reduction of cyst size as microsurgical fenestration[15]. Thus, pointing to the fact that the efficacy of the surgical intervention is better assessed by clinical improvement rather than radiological cyst size reduction.

However, our study showed a statistically significant difference in the rate of post-operative radiologic cyst

volume reduction among the three surgical modalities with *P-Value* 0.023 (S), favoring microsurgical fenestration over the remaining two modalities. Moreover, on comparing between microscopic and endoscopic fenestration, statistically significant difference was found with *P-value* 0.01 (S).

Although the microsurgical fenestration and cystoperitoneal shunt are efficient techniques, endoscopic fenestration has been described as a very safe alternative. It is assumed to be less invasive treatment and avoid significant complications associated with craniotomy and shunt insertion (such as subdural hygroma and shunt infection, malfunction, and dependence)[19,20].

A meta-analysis of Sylvian fissure cysts by ***Chen et al.***[17] reported different complication rstes for the different interventions with craniotomy and microscopic fenestration having a high rate of short-term complications mainly subdural hygromas whereas cystoperitoneal shunts have a higher rate of long-term complications as shunt infections, dysfunction and risk of shunt dependency[21], which carries a lifelong morbidity from shunt complications such as, malfunction, obstruction, shunt- dependency, slit-ventricle syndrome and the lifelong psychological impact on the patients for having an implanted hardware that's liable for many complications. In our study, the incidence of complications were comparable to those of the ***Chen et al.***[17], however, due to the small number of CP shunts, the long-term complications may be underrepresented.

Out of the 13 studies included in our review, only ***El Damaty et. al.***,[8] commented on the post-operative complications rate in CP shunt group. Having a total number of only 10 patients operated for CP shunt, which is a relatively simple procedure comparing to microsurgical or endoscopic fenestration, no complications were reported within them. The vast discrepancy in the size of the groups rendered our results, regarding complications after CP shunt, liable to under coverage bias. Larger series of CP shunts showed need for reoperation in approximately 30%of cases either for failures or complications[22]. In addition, complications assessment can be affected due to insufficient follow-up period.

We've noted that, regardless the performed intervention, ***Spacca et al.***[7], ***Levy et al.***[10] and ***Tamimi et al.***[14] showed the highest incidence of complications as 40%, 40% and 45% respectively. A remarkable notice is that the first 2 studies were performed only on patients with middle fossa arachnoid cysts and ***Tamimi et al.***[14] included 11 patients with middle fossa cysts out of 20 total study patients (55%). Thus, this may suggest a possible correlation between the location of the arachnoid cyst and the liability for post-operative complications, as for our study, temporal fossa cysts were associated with higher incidence of complications.

We tried to statistically test for a possible correlation among location, surgical approach and complications of different arachnoid cysts, but unfortunately, the extracted data from the included studies was insufficient. For example, ***Holst et. al.***[15] categorized the patients according to the cyst location, but didn't mention the surgical approach that was done in each location subgroup, neither allocated the complications to a specific location subgroup. This issue was also encountered in ***Boutarbouch et al.***,[9]. In ***Khan et. al,***[4]. Location subgroups were only as supratentorial and infratentorial cysts, which again didn't allow to correlate the mentioned complications neither with the cyst location nor with the surgical approach.

Taking the previously mentioned data from the literature into consideration, and looking into our study results, endoscopic technique appears to have a lower rate of complications on both short and long term aspects, compared to microsurgical technique, and CP shunting that showed higher rates of short and long term complication, respectively as mentioned by ***Chen et al.***[17]. Endoscopic fenestration surgery was also reported to be associated with a shorter hospital stay[23].

Regarding the rate of recurrence, our results are comparable to those of ***El Damaty et. al,***[8] showing recurrence rates among the three surgical modalities, the lowest was observed in the endoscopic group (19%) and the highest rate encountered within the CP shunt group (47.6%). There was a statistically significant difference among the three groups with *P-value* 0.016 (S), favoring endoscopic fenestration in terms of recurrence.

Absence of permanent neurologic deficits was reported in seven out of the included thirteen studies, the remaining studies didn't comment on permanent deficits, Follow-up is crucial for accurate assessment of outcomes.

Study limitations:

The nature and types of the available literature being nonrandomized, observational was associated with several methodological issues, including publication bias, selection bias, reporting bias (not all outcomes were reported in all papers), and lack of standardization in the study design. These issues highlight the inherent limitations in any

review based on observational data and the need for future large prospective studies. Other significant confounding factors include the operative decisions, preference and experience of the different surgeons.

Outcome measures weren't objectively described and determined. For example; none of the included studies categorized complications on short or long-term bases. This could be an important factor affecting the interpretation of the extracted data and the significance of the results.

CONCLUSION

Our systematic review and meta-analysis showed that the three surgical options are efficient in terms of symptomatic improvement with no statistically significant difference between them, however, microsurgical fenestration is favored over CP shunt with statistically significant difference. Microsurgical fenestration was followed by the highest incidence of postoperative cyst volume reduction (86.2%) with statistically significant difference. On the other hand, endoscopic fenestration was accompanied by the lowest rate of recurrence (19%) with statistically significant difference. The three modalities showed statistically non-significant difference in terms of post-operative short-term complications and permanent neurological deficits.

Further prospective randomized controlled trials are needed to evaluate the surgical options, with subgrouping of the cases according to location, size and radiological features of the arachnoid cyst, using objective outcome definitions and assessment, and ensuring a consistent long follow-up to minimize the uncertainty in some data such as long-term complications and incidence of permanent deficits.

CONFLICT OF INTERESTS

There is no conflicts of interest.

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الخيارات الجراحية المختلفة لعلاج التكيسات العنكبوتية داخل الجمجمة: استعراض منهجي

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الخلفية: الأكياس العنكبوتية هي أكياس غير ورمية مملوءة بالسائل الدماغي الشوكي ومبطنة بأغشية الأم العنكبوتية. حالات الأكياس العنكبوتية الصغيرة لا تظهر عليها أعراض في الغالب . أما الأكياس العنكبوتية الكبيرة غالبا ما تكون مصحوبة بأعراض لأنها تضغط على انسجة المخ المجاورة لها مما يتسبب في ارتفاع ضغط المخ أوحدوث تشنجات وفقًا لموقعها و حجمها، وبالتالي، يجب علاجها جراحيًا. ونظرًا لوجود العديد من الخيارات الجراحية، فيجب اختيار أنسب تدخل جراحي وفقًا لكل نوع من أنواع الأكياس العنكبوتية. وتهدف الأبحاث الجارية إلى تعزيز فهمنا لأعراض هذه الاكياس، وتطوير وسائل التشخيص، وتحسين استراتيجيات العلاج لتحسين النتائج .

الهدف من هذه الدراسة: هو المقارنة بين الأساليب الجراحية المختلفة في علاج الأكياس العنكبوتية داخل الجمجمة المصحوبة بأعراض، وخاصة الفتحات المجهرية ، والفتحات بالمنظار، وتركيب صمام من الكيس الى البريتون من حيث الفعالية والمضاعفات على المدى القصير والطويل.

مصادر البيانات: قواعد بيانات ميدلاين (PubMed Medscape، EMBASE، ScienceDirect)، قاعدة بيانات كوكرين للمراجعات المنهجية) حتى عام ٢٠٢٤.

الخلاصة: أظهرت بياناتنا أن الطرق الجراحية الثلاثة فعالة من حيث التحسن الاكلينيكي ، ولكن الفتحات المجهرية مفضلة على الصمام. وقد تبع عملية فتح الثقوب الجراحية بالميكروسكوب أعلى معدل لانخفاض حجم الكيس بعد الجراحة (٨٦,٢٪) مع وجود فرق كبير إحصائيًا. ومن ناحية أخرى، كان فتح الثقوب بالمنظار مصحوبًا بأقل معدل تكرارالتدخل الجراحي (١٩٪) مع وجود فرق كبير إحصائيًا. ولم يظهر اختلاف بين الطرق الثلاث في المضاعفات قصيرة المدى بعد الجراحة والعجز العصبي الدائم.

ويوصى بإجراء المزيد من التجارب السريرية العشوائية لتقييم الخيارات الجراحية، باستخدام معايير واضحة وصريحة للإدراج، وتعريفات وتقييم النتائج الموضوعية، وضمان متابعة طويلة للوقوف على احتمالات المضاعفات طويلة المدى وحالات العجز الدائم.