Bone Cement vs Bone Flap Replacement: A Comparative Meta-Analysis of Posterior Fossa Craniotomy Complications

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Introduction

Posterior fossa surgeries are often performed to treat infratentorial pathologies such as tumors that increase intracranial pressure. Traditionally, bone flap replacement is utilized for closure, but more recently bone cement has been implemented. This study aims to address the information gap of comparative postoperative data between these two techniques via meta-analysis comparing incidence of postoperative cerebrospinal fluid leakage and other complications when utilizing bone cement versus bone flap replacement in posterior fossa craniotomies.

Methods

Following a literature review, search parameters for a systematic review were identified and relevant studies were sorted based on PRISMA guidelines and meta-analysis selection criteria.

Twenty-one articles were included from systematic review and statistical analysis on postoperative complications were performed.

Targeted complications analyzed include: CSF leakage, pseudomeningocele formation, and infection.

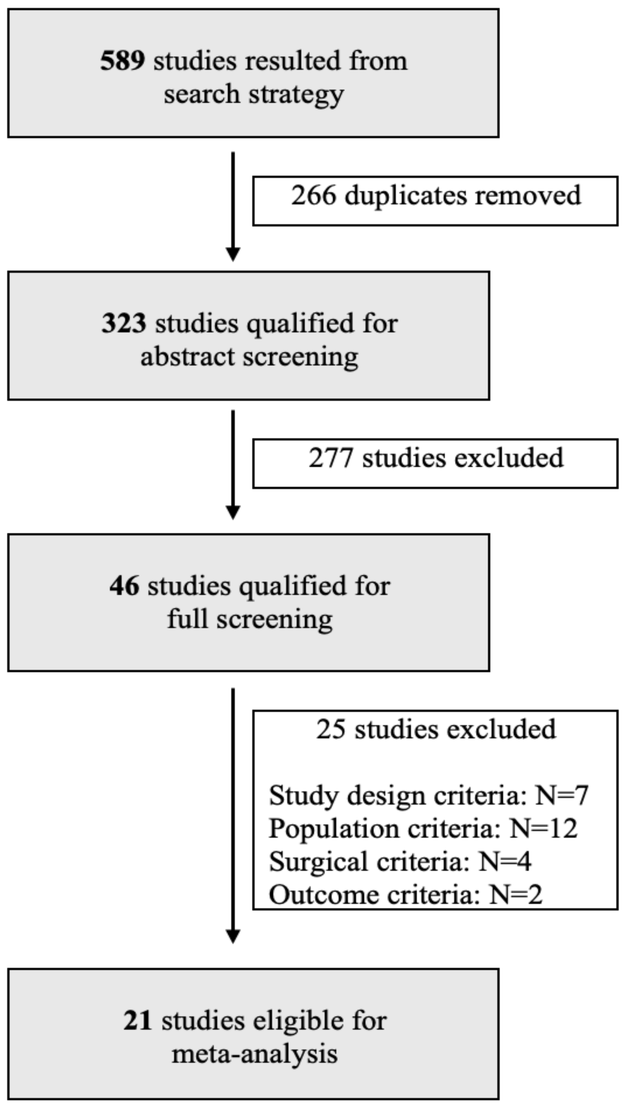

Figure 1. Flowchart schematic of study selection

Results

	CSF Leak	Pseudomeningocele Formation	Infection
Bone cement			
Incidence (SD)	**3.47%** (±1.82%)	**2.43%** (±1.59%)	**1.85%** (±1.65%)
CI [Min, Max]	±1.1% [2.37%, 4.57%]	±1.2% [1.23%, 3.63%]	±1.1% [0.75%, 2.95%]
Bone flap			
Incidence (SD)	**8.36%** (±4.67%)	**9.22%** (±8.43%)	**6.85%** (±5.28%)
CI [Min, Max]	±2.5% [5.89%, 10.86%]	±4.4% [4.82%, 13.62%]	±2.8% [4.05%, 9.65%]

Figure 2. Comparative complication rates from bone cement versus bone flap replacement usage in posterior fossa craniotomies

Discussion

With bone flap replacement:

- CSF leakage was 8.36% (95% CI 5.89% to 10.86%)
- Pseudomeningocele formation was 9.22% (95% CI 4.82% to 13.62%)
- Infection was 6.85% (95% CI 4.05% to 9.65%).

With bone cement usage:

- CSF leakage was 3.47% (95% CI 2.37% to 4.57%)
- Pseudomeningocele formation was 2.43% (95% CI 1.23% to 3.63%)
- Infection was 1.85% (95% CI 0.75% to 2.95%).

Study	Corresponding Number
Kushel et al. 2019	1
Dubey et a. 2009	2
Lam et al. 2012	3
Wolfson et al. 2021	4
Steinbok et al. 2007	5
Hosainey et al. 2014	6
Hadanny et al. 2016	7
Ou et al. 2019	8
Legnani et al. 2013	9
Prell et al. 2011	10
Gnanalingham et al. 2003	11
Steinbok and Cochrane 2000	12
Razak et al. 2022	13
Gnanalingham et al. 2002	14
Wolfson et al. 2021	15
Zhang et al. 2021	16
Ou et al. 2019	17
Inoue et al. 2021	18
Aldahak et al. 2017	19
Heymanns et al. 2016	20
Kim et al. 2020	21
Luryi et al. 2017	22
Hwa et al. 2021	23

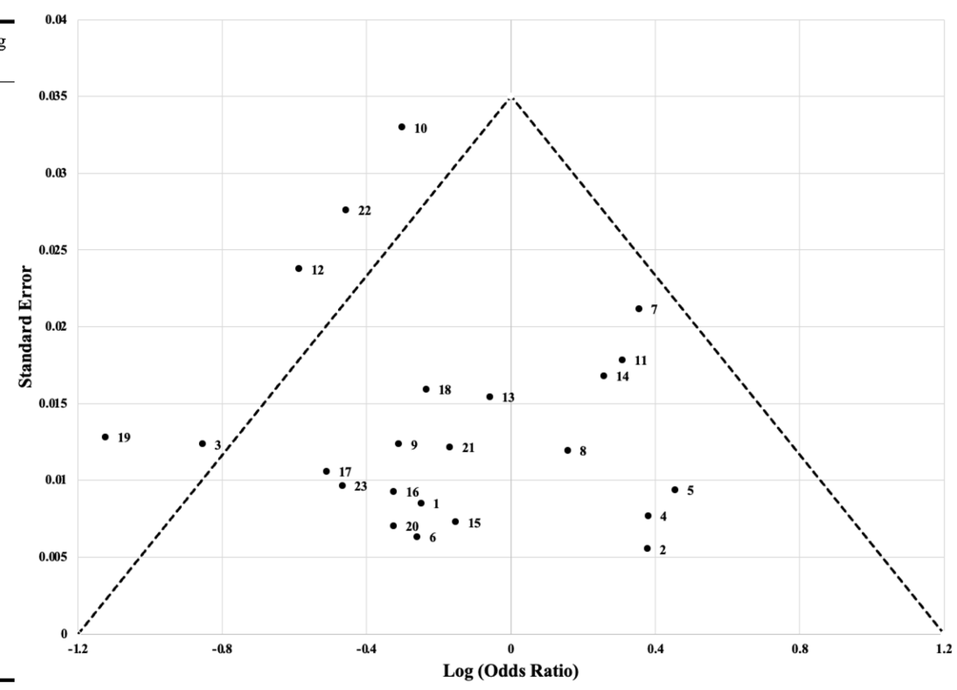

Figure 3. Funnel plot of included studies

The odds ratio of CSF leak, pseudomeningocele formation, and infection was 0.39 (95% CI 0.229 to 0.559), 0.25 (95% CI 0.137 to 0.353), and 0.26 (95% CI 0.149 to 0.363) respectively with the use of bone cement compared to craniotomy. The calculated heterogeneity index (I^2) in this meta-analysis is 24.54%.

Conclusion

Outcomes demonstrated in this meta-analysis revealed an overall decreased incidence of postoperative complications rates of CSF leak, pseudomeningocele formation, and infection when using bone cement compared to bone flap in posterior fossa craniotomies.

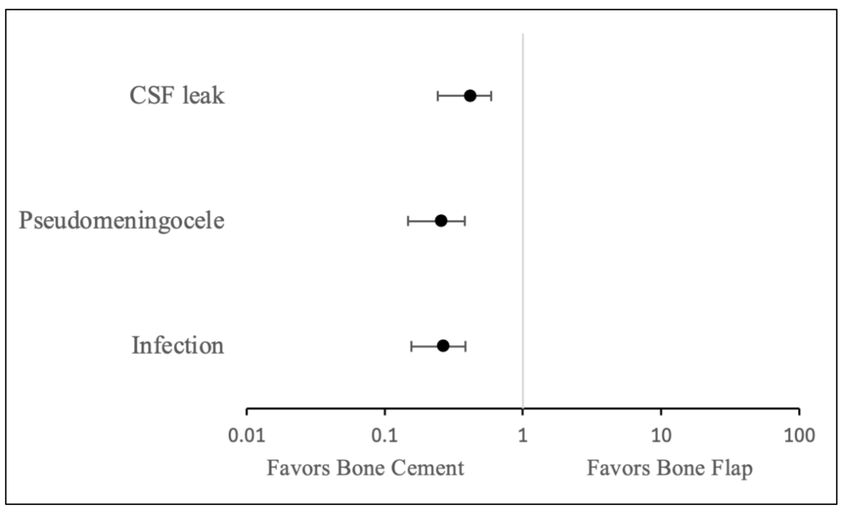

Figure 4. Pooled analysis of risk rations of measured outcomes

References

- Alhantoobi MR, Kesserwan MA, Khayat HA, Lawasi M, Sharma S. Rates of cerebrospinal fluid leak and pseudomeningocele formation after posterior fossa craniotomy versus craniectomy: A systematic review and meta-analysis. Surg Neurol Int. 2023 Apr 21;14:140. doi: 10.25259/SNI_125_2023. PMID: 37151452; PMCID: PMC10159278.
- Dubey A, Sung WS, Shaya M, Patwardhan R, Willis B, Smith D, Nanda A. Complications of posterior cranial fossa surgery--an institutional experience of 500 patients. Surg Neurol. 2009 Oct;72(4):369-75. doi: 10.1016/j.surneu.2009.04.001. Epub 2009 Jul 14. PMID: 19604553.
- Krishnan SS, Nigam P, Manuel A, Vasudevan MC. Bone Sandwich Closure Technique for Posterior Fossa Craniectomy. J Neurol Surg B Skull Base. 2020 Feb;81(1):8-14. doi: 10.1055/s-0039-1678602. Epub 2019 Feb 4. PMID: 32021744; PMCID: PMC6997009.
- Slot EMH, van Baarsen KM, Hoving EW, Zuithoff NPA, van Doormaal TPC. Cerebrospinal fluid leakage after cranial surgery in the pediatric population-a systematic review and meta-analysis. Childs Nerv Syst. 2021 May;37(5):1439-1447. doi: 10.1007/s00381-021-05036-8. Epub 2021 Feb 4. PMID: 33538867; PMCID: PMC8084768.

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