Adjunctive Embolization for Chronic Subdural Hematoma: Does it Reduce Recurrence?

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Chronic subdural hematomas (CSDH) present a persistent challenge in neurosurgery, frequently recurring even after successful surgical drainage. This common complication often necessitates repeat procedures, increasing patient morbidity and healthcare costs. The question of how to effectively prevent these recurrences has driven interest in adjunctive therapies, particularly those targeting the underlying pathophysiology of CSDH expansion.

One such approach, embolization of the middle meningeal artery (EMMA), gained traction based on observational data suggesting its role in reducing recurrence. The EMMA-Can randomized clinical trial, published in JAMA, directly investigated whether this adjunctive procedure truly impacts recurrence rates following surgical drainage.1

KEY TAKEAWAYS

- The Pivot: Adjunctive middle meningeal artery embolization did not significantly reduce chronic subdural hematoma recurrence after surgical drainage.
- The Data: The 6-month recurrence rate was 18.5% in the EMMA group vs 19.2% in the control group (HR 0.96; 95% CI, 0.72-1.28; P=.77).
- The Action: Clinicians should continue to rely on surgical drainage as the primary intervention for symptomatic CSDH, with EMMA not currently supported as a routine adjunctive measure for recurrence prevention.

Chronic subdural hematomas, collections of blood and fluid between the dura mater and the arachnoid membrane, are a common neurosurgical presentation, particularly in older adults and those on anticoagulants. Surgical drainage, typically via burr hole craniostomy or craniotomy, remains the standard of care for symptomatic CSDH. But the Achilles' heel of surgical management is recurrence, which can affect up to 30% of patients and often requires repeat operations, prolonging hospital stays and increasing the risk of complications. The search for adjunctive therapies to mitigate this recurrence risk has been ongoing, with various medical and procedural interventions explored.1

The EMMA-Can trial aimed to definitively assess the role of middle meningeal artery embolization as an adjunctive treatment. Shankar JJS, Alcock S, and Kashani N designed a multicenter, randomized clinical trial to compare surgical drainage alone against surgical drainage followed by EMMA. The trial enrolled 1,240 adult patients (aged 18 years or older) with symptomatic chronic subdural hematoma requiring surgical evacuation. Patients were recruited from 28 neurosurgical centers across Canada between January 2022 and December 2025. The primary endpoint was symptomatic

CSDH recurrence requiring reoperation within 6 months of initial surgical drainage. Secondary endpoints included functional outcomes measured by the modified Rankin Scale (mRS) at 6 months, all-cause mortality, and adverse events.1

Trial Design and Patient Characteristics

Investigators randomized patients 1:1 to either surgical drainage plus EMMA or surgical drainage alone. The EMMA procedure involved superselective catheterization and embolization of the middle meningeal artery, typically performed within 72 hours of surgical drainage. Patients in both arms received standard postoperative care, including monitoring for recurrence and management of underlying risk factors. The mean age of the enrolled population was 78.2 years (SD 8.5), with 68% being male. A significant proportion of patients, 42%, were on antiplatelet or anticoagulant therapy at presentation, a known risk factor for CSDH development and recurrence. The median hematoma volume at presentation was 120 mL (IQR 85-160 mL). Baseline mRS scores were comparable between the two groups, with a median mRS of 3, indicating moderate disability.1

The trial excluded patients with acute subdural hematomas, those requiring immediate life-saving craniotomy, or those with a known history of severe coagulopathy that could not be reversed. Patients with a life expectancy of less than 3 months or those who were unable to undergo angiography due to severe renal impairment or contrast allergy were also excluded. This careful selection aimed to create a homogeneous population where the effect of EMMA could be clearly isolated. The primary outcome, symptomatic recurrence requiring reoperation, was adjudicated by an independent committee blinded to treatment assignment. This rigorous approach minimized bias in assessing the most critical clinical endpoint.1

The Primary Outcome: Recurrence Rates

Adjunctive EMMA did not significantly reduce the risk of symptomatic CSDH recurrence requiring reoperation within 6 months. The recurrence rate was 18.5% (115 of 620 patients) in the EMMA group compared with 19.2% (119 of 620 patients) in the control group. This translated to a hazard ratio of 0.96 (95% CI, 0.72-1.28; P=.77). The lack of a statistically significant difference was consistent across various subgroup analyses, including age, sex, initial hematoma volume, and use of antithrombotic agents. This finding directly challenges the prevailing hypothesis that EMMA, by occluding the presumed source of rebleeding from dural neovascularization, would offer a tangible benefit.1

The cumulative incidence curves for recurrence overlapped almost entirely throughout the 6-month follow-up period, visually reinforcing the absence of a treatment effect. The median time to recurrence was also similar between groups, approximately 45 days in both arms. This suggests that EMMA did not even delay recurrence, let alone prevent it. The trial's large sample size provided ample power to detect a clinically meaningful difference if one existed, making the negative result particularly robust.1

Secondary Endpoints and Safety Profile

Functional outcomes at 6 months, assessed by the modified Rankin Scale, also showed no significant difference between the two groups. The proportion of patients achieving an mRS score of 0-3 (indicating good functional recovery) was 65.1% in the EMMA group and 64.5% in the control group (odds ratio 1.03; 95% CI, 0.82-1.29; P=.79). All-cause mortality at 6 months was 4.8% in the EMMA group and 5.1% in the control group (HR 0.94; 95% CI, 0.58-1.53; P=.80). These secondary outcomes align with the primary finding, indicating no discernible clinical benefit from adjunctive EMMA.1

The safety profile of EMMA was generally acceptable, but the procedure was not without risks. Procedure-related complications occurred in 3.1% of patients in the EMMA group, compared to 0.8% in the control group (P=.001). These complications included transient ischemic attack (TIA) in 1.2% of EMMA patients, non-disabling stroke in 0.5%, and minor vascular access site complications in 1.4%. While most complications were transient or minor, the occurrence of stroke, even at a low rate, adds to the risk-benefit calculation. The control group's complications were primarily related to surgical drainage itself or general anesthesia.1

The EMMA procedure itself added an average of 60 minutes to the overall treatment time and required additional resources, including specialized angiography suites and interventional neuroradiologists. The cost implications of a procedure that offers no clinical benefit, but carries additional risks and resource demands, are substantial. This is particularly relevant in healthcare systems where resource allocation is a constant concern. The trial did not formally assess cost-effectiveness, but the data strongly suggest EMMA would not be cost-effective as an adjunctive therapy.1

Where it Falls Short

The EMMA-Can trial was well-designed and adequately powered, but some limitations warrant consideration. The primary outcome focused on symptomatic recurrence requiring reoperation. It did not capture asymptomatic recurrences that might have been observed radiographically but did not necessitate further intervention. While symptomatic recurrence is arguably the most clinically relevant endpoint, a reduction in asymptomatic recurrences could still indicate a biological effect of EMMA. But, given the complete overlap in symptomatic recurrence rates, it is unlikely that a significant difference in asymptomatic recurrence would translate to a meaningful clinical benefit.1

The trial also did not explore different embolization techniques or materials, which could theoretically influence outcomes. All centers used standard embolization coils or liquid embolic agents, but variations in operator experience or specific techniques might exist. Still, the multicenter nature of the trial, involving a broad range of neurosurgical and interventional neuroradiology teams, enhances the generalizability of the results. The trial's 6-month follow-up period is standard for CSDH recurrence studies, but longer-term data might reveal subtle differences, though the initial curves suggest this is improbable. For a deeper understanding of long-term neurological outcomes following traumatic brain injury, including those that might predispose to CSDH, clinicians might consult TBI Linked Bidirectionally With Psychiatric and Neurologic Conditions.1

One might also consider the potential for selection bias, despite randomization. Patients referred for EMMA might represent a specific subset of CSDH patients, perhaps those with more recalcitrant or rapidly recurring hematomas. But, the broad inclusion criteria and multicenter design aimed to mitigate this. The trial's findings are definitive for the patient population studied, but whether EMMA might benefit a highly selected subgroup, such as those with multiple prior recurrences or specific angiographic findings, remains an open question for future research, though the current data do not support such an approach. Clinicians seeking comprehensive neurological references may find the Oxford Handbook of Neurology (2nd ed) a valuable resource for quick reference in such complex cases.1

The EMMA-Can trial provides clear evidence that adjunctive middle meningeal artery embolization does not reduce the risk of chronic subdural hematoma recurrence after surgical drainage. The procedure adds risk and cost without offering a clinical benefit in terms of reoperation rates, functional outcomes, or mortality. The field now needs to focus on other avenues for recurrence prevention, perhaps exploring novel medical therapies or refining surgical techniques. The current data do not support the routine use of EMMA as an adjunct to surgical drainage for CSDH.

CLINICAL IMPLICATIONS

The EMMA-Can trial delivers a clear, if somewhat deflating, message: adjunctive middle meningeal artery embolization does not improve outcomes for patients undergoing surgical drainage of chronic subdural hematoma. This finding should prompt a re-evaluation of current practice in centers where EMMA has been adopted as a routine adjunct. The procedure carries its own risks and resource burden, and without a demonstrable benefit in reducing recurrence or improving functional outcomes, its continued use for this indication is difficult to justify.

For neurosurgeons and interventional neuroradiologists, this means a return to basics. Surgical drainage remains the cornerstone of CSDH management. Efforts to reduce recurrence should focus on optimizing surgical technique, managing underlying coagulopathies, and perhaps exploring medical therapies that target inflammation or neovascularization more broadly, rather than a focal arterial occlusion that appears ineffective.

> The enthusiasm for EMMA, largely driven by retrospective series and biological plausibility, has now been tempered by robust randomized data.
> The implications for healthcare systems are also significant. EMMA is a costly procedure, requiring specialized equipment and personnel. Eliminating its routine use as an adjunctive therapy for CSDH will free up resources that can be redirected to other, evidence-based interventions. This trial serves as a stark reminder that even biologically appealing interventions must withstand the scrutiny of rigorous randomized controlled trials before widespread adoption.

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REFERENCES

1. 1. Shankar JJS, Alcock S, Kashani N. Management of Chronic Subdural Hematoma With Adjunctive Embolization of Middle Meningeal Artery: The EMMA-Can Randomized Clinical Trial. JAMA 2026.

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