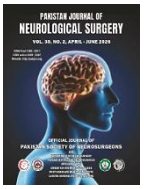

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Original Research

Perioperative Use of Diluted Hydrogen Peroxide During Convexity Meningioma Resection: A Retrospective Observational Study

Hanif Ur Rahman[1], Ramzan Hussain[1], Akram Ullah[3], Mumtaz Ali[1], Amjad Ali[2], Yasir Ashraf[2]

[1]Department of Neurosurgery, Ali Institute of Neurosciences, Irfan General Hospital, Peshawar

[2]Department of Physiotherapy, Ali Institute of Neurosciences, Irfan General Hospital, Peshawar

[3]Department of Neurosurgery, Prime Teaching Hospital, Peshawar – Pakistan

ABSTRACT

Objective: Convexity meningiomas are the most common extra-axial brain tumors and can be challenging to remove due to high vascularity. Hydrogen peroxide (H_2O_2) has historically been used in neurosurgical procedures because of its oxidizing and hemostatic properties; however, evidence regarding its role in convexity meningioma surgery remains limited. The study aimed to evaluate the feasibility and perioperative outcomes associated with the use of diluted hydrogen peroxide during convexity meningioma surgery.

Materials & Methods: This retrospective study included 86 patients who underwent convexity meningioma surgery at the Ali Institute of Neurosciences from January 2017 to March 2022. Diluted hydrogen peroxide was applied during surgery to alter tumor consistency, control bleeding, and reduce tumor blood supply. Patient demographics, clinical features, and surgical outcomes were analyzed descriptively.

Results: There were 42 males (48.8%) and 44 females (51.2%) with a mean age of 56.3 years. Headache was the most common symptom (72.1%). Gross total resection was achieved in 78 cases (90.7%), with minimal bleeding in most patients. Perioperative complications occurred in 12 cases (13.9%).

Conclusion: The use of perioperative diluted hydrogen peroxide during convexity meningioma surgery appeared feasible and was associated with acceptable surgical outcomes in this retrospective series. However, due to the absence of a control group, definitive conclusions regarding superiority or direct effects on bleeding reduction and tumor resection cannot be established.

Keywords: Convexity meningioma, hydrogen peroxide, outcomes, peri-operative complication, surgical resection.

Corresponding Author: Yasir Ashraf
Ali Institute of Neurosciences,
Irfan General Hospital, Peshawar
Email: *Yasirkhattak099@gmail.com*

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INTRODUCTION

Meningiomas are the most prevalent type of intracranial tumors, accounting for 37.6% of all primary brain tumors in adults, and with an incidence of 8.83 per 100,000 according to the most recent data from the Central Brain Tumor Registry of the United States. On the other hand, they are rare in both sexes in children and adolescents (0.4%–4.6%).[1] The convexity is the most typical location for meningiomas and is categorized as one of the most frequent extra-axial tumors seen in neurosurgery: convexity meningiomas.[2,3] Due to the rising incidence of meningiomas with aging, the median age at which a meningioma is diagnosed is 65.[4.] Additionally, there is a clear gender bias in the adult population, with a female: male ratio of 3:1 rising to 9:1 for spinal injuries.[5] "Wait and see" is the best course of action for meningiomas that are tiny and asymptomatic.[6] In cases unresponsive to conservative management and progressive tumors, the preferred course of treatment for symptomatic convexity meningiomas has been gross tumor excision. Despite typically having benign histology, intracranial meningiomas can present a considerable challenge to the neurosurgeon due to their vast vascularity. Extensive bleeding can pose a significant risk to the patient and increase the difficulty of resection.[7] A potent oxidizer, hydrogen peroxide. It combines with the blood's catalase and injured cells in the surgical field to produce water and oxygen ($H_2O_2 \rightarrow H_2O + O_2$). Although hydrogen peroxide has historically been used in neurosurgical procedures for hemostasis and tissue dissection, contemporary evidence regarding its role in convexity meningioma surgery remains limited.[9] Therefore, this study aimed to evaluate the feasibility and perioperative outcomes associated with the use of diluted hydrogen peroxide during convexity meningioma resection at our institution.

MATERIALS & METHODS

Study Design & Setting

This retrospective study was conducted at the Ali Institute of Neurosciences, Irfan General Hospital, Peshawar. The study was conducted in accordance with the ethical guidelines outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board of Ali Institute of Neurosciences. Patient confidentiality was maintained throughout the study, with all data analyzed in anonymized and aggregated form. The study population included patients who underwent surgical resection for convexity meningiomas at the Ali Institute of Neurosciences between January 2017 and March 2022, with a sample size of 86. **Ethical Review Board Approval** was obtained from the IRB of AINS-IGH (Ref:46/AINS/2018).

Inclusion Criteria

Patients of all ages and genders with a confirmed diagnosis of convexity meningioma based on radiological imaging and histopathological examination.

Exclusion Criteria

Patients with contraindications to surgical intervention, known allergies to hydrogen peroxide, or incomplete medical records were excluded from the study.

Data Collection

Retrospective data were collected from electronic medical records, radiological reports, surgical notes, and pathology reports. Intraoperative bleeding severity was categorized by the operating surgeon as minimal, moderate, or significant based on overall surgical field assessment and hemostatic requirements. Collected data included demographic information (age, gender), pre-operative clinical presentation, radiological findings, tumor size and location, surgical

approach, duration of surgery, peri-operative complications, and post-operative outcomes.

Mechanism of Hydrogen Peroxide

Hydrogen peroxide has been used in neurosurgical procedures because of its oxidizing, cleansing, and hemostatic properties. When applied to tissue, it reacts with catalase present in blood and cells, producing oxygen bubbles that may assist in mechanical tissue dissection and local hemostasis. In meningioma surgery, diluted hydrogen peroxide may contribute to temporary tumor devascularization and facilitate identification of tissue planes. However, its exact mechanism of action remains incompletely understood, and cautious use is advised because of potential complications reported in the literature.

Technique of Application of Hydrogen Peroxide

After making bone flaps over the tumor site, a circumferential dural incision is made along the attached dura, and a few radial releasing incisions are given in the dura to identify the tumor brain cleavage line. 5cc of hydrogen peroxide is diluted in 10 cc normal saline and injected/infiltrated into the dura in the tumor. Continuous irrigation with normal saline is continued. Within seconds of application, oxygen bubbles are generated within the surgical field, which may assist in temporary devascularization and facilitate tumor dissection. Continuous saline irrigation was maintained throughout the procedure to minimize potential complications. The major blood vessels supplying the tumor can be coagulated in separate cuts, and thus the tumor can be excised safely.

Data Analysis

Data was analyzed using appropriate statistical methods. Descriptive statistics, such as means, medians, standard deviations, and percentages, were used to summarize demographic and clinical characteristics of the study population.

RESULTS

Patient Characteristics and Demographics

A total of 86 patients who underwent surgical resection for convexity meningiomas were included in the study. The study population consisted of 42 males (48.8%) and 44 females (51.2%), with a mean age of 56.3 years (SD 12.7). The age distribution of the study population is summarized in Table 1.

Table 1: *Patient Characteristics & Demographics.*

Age Group (years)	Number of Patients	Percentage (%)
<20	2	2.3
20-40	8	9.3
41-60	46	53.5
61-80	28	32.6
>80	2	2.3
Total	86	100.0

Clinical Presentations of Convexity Meningiomas

The most common clinical presentations of convexity meningiomas in the study cohort included headache in 62 patients (72.1%), seizures in 23 patients (26.7%), focal neurological deficits in 34 patients (39.5%), visual disturbances in 19 patients (22.1%), and other symptoms in 8 patients (9.3%). Table 2 provides an overview of the clinical presentations observed in the patient population.

Table 2: *Clinical presentations of Convexity Meningioma.*

Clinical Presentation	Number of Patients	Percentage (%)
Headache	62	72.1
Seizure	23	26.7
Focal Neurological Deficit	34	39.5
Visual Disturbances	19	22.1
Others	8	9.3
Total	86	100.0

Outcomes of Hydrogen Peroxide Application

The use of diluted hydrogen peroxide during convexity meningioma surgery was associated with acceptable surgical outcomes in this patient series. Out of 86 patients, 78 (90.7 percent) had complete tumor removal, while 8 (9.3 percent) had partial removal. Bleeding during surgery was minimal in 60 patients (69.8 percent), moderate in 24 patients (27.9 percent), and significant in 2 patients (2.3 percent). Surgery lasted between 120 and 380 minutes, with an average time of 253.4 minutes (SD 45.6). Perioperative complications occurred in 12 patients (13.9 percent), including 5 infections, 4 CSF leaks, and 3 cases with neurological problems. Full details of the outcomes with hydrogen peroxide use are shown in Table 3.

Table 3: *Outcomes of Hydrogen Peroxide Application.*

Outcome	Number of Patients	Percentage (%)
Gross Total Resection	78	90.7
Subtotal Resection	8	9.3
Minimal Bleeding	60	69.8
Moderate Bleeding	24	27.9
Significant Bleeding	2	2.3
Peri-operative Complications	12	13.9
Total	86	100.0

DISCUSSION

This study aimed to explore how using diluted hydrogen peroxide during surgery can make the removal of convexity meningiomas safer. Our findings give useful information about patient characteristics, common symptoms of convexity meningiomas, and the outcomes when hydrogen peroxide is used during surgery. In our group, there were slightly more females, 44 (51.2%), than males, and the average age was 56.3 years. This fits with what is usually seen, as meningiomas are most often diagnosed in middle-aged and older adults. Other studies have reported a similar mean age of 50.4 years.[8,9] The distribution of cases across different age groups shows that convexity meningiomas can affect people at different stages of life. In our study, patients showed a range of symptoms. Headaches were the most common, seen in 72.1 percent of patients. This matches other reports, which describe headache as a frequent first symptom of meningiomas, caused by their slow growth and pressure on nearby brain tissue.[10,12] Seizures and localized neurological problems were also observed, reflecting how these tumors can press on surrounding brain areas. A large review of 33 studies published between 1980 and 2014 found that 29 percent of meningioma patients had seizures before surgery.[13] Hydrogen peroxide (H2O2) has many uses, especially in medicine, where it helps fight bacteria and control bleeding. Neurosurgeons have used it for more than a century for these purposes.[14,15] In our study, using diluted hydrogen peroxide during convexity meningioma surgery showed good results. Gross total resection was achieved in most patients in this series; however, due to the absence of a comparative control group, the specific contribution of hydrogen peroxide to resection outcomes cannot be determined. Diluted hydrogen peroxide may assist in temporary tumor devascularization and facilitate surgical dissection; however, its exact mechanism and direct impact on surgical outcomes remain uncertain. Most patients demonstrated minimal to moderate intraoperative bleeding; however, the absence of an objective comparison limits conclusions regarding the direct hemostatic effect of hydrogen peroxide. Another study found that it also made tumor removal faster and removed the need for pre-surgery procedures to block blood flow.[16] Still, 13.9 percent of patients had complications, so hydrogen peroxide should be used carefully, depending on the patient and risks. Hydrogen peroxide use during neurosurgical procedures has been associated with potential complications, including oxygen embolism, cardiovascular instability, tension

pneumocephalus, and direct neural tissue injury. Although such complications were not specifically observed in our series, awareness of these risks remains essential. Careful dilution, controlled application, and continuous saline irrigation are important precautions during its use. Some of the complications seen included infections, CSF leaks, and neurological problems, highlighting the need for careful technique and proper patient selection during meningioma surgery. In other reports, hydrogen peroxide use in neurosurgery has been linked to serious issues such as direct brain injury, stroke, tension pneumocephalus, and even systemic oxygen embolism.[17] The results of some studies have also documented the cardiac complications associated with the use of hydrogen peroxide. A study by Toma Spiriev, Hemanshu Prabhakar, and colleagues has reported the incidence of cardiovascular complications as 3%.[18] The operative duration observed in this study was comparable to previously reported operative times for convexity meningioma surgery. However, due to the absence of a control group, it cannot be concluded that the use of hydrogen peroxide directly influenced surgical duration. Post-operative rehabilitation, including physiotherapy, may support the recovery of neurological function in patients undergoing meningioma resection.[19]

LIMITATIONS

This study has several limitations, including its retrospective single-center design and absence of a control group, which limit the ability to establish a causal relationship between hydrogen peroxide use and improved surgical outcomes. In addition, intraoperative bleeding assessment was subjective and based on surgical judgment rather than objective quantitative measurement. Therefore, the findings primarily demonstrate the feasibility of diluted hydrogen peroxide use during convexity meningioma surgery. Larger prospective multicenter studies with appropriate control groups are required to validate these observations.

CONCLUSION

Diluted hydrogen peroxide use during convexity meningioma surgery appeared feasible in this retrospective series and was associated with acceptable surgical outcomes. However, the absence of a control group limits the assessment of its true efficacy or superiority. Prospective controlled studies are necessary to further evaluate its safety profile and potential role in meningioma surgery.

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Additional Information

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Human Subjects: Consent was obtained from all patients in this study.
Conflicts of Interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following:
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Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.
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AUTHORS CONTRIBUTIONS

Role	Contributing Author(s)	Role	Contributing Author(s)
Conceptualization	Hanif Ur Rahman, Mumtaz Ali	Data Curation	Mumtaz Ali
Methodology	Akram Ullah, Ramzan	Writing – Original Draft/Literature Review	Mumtaz Ali
Software	Ramzan Ullah	Writing – Review & Editing	Amjad Ali
Validation	Yasir Ashraf	Visualization	Akram Ullah
Formal analysis	Mumtaz Ali, Hanif Ur Rahman	Supervision	Mumtaz Ali
Investigation	Mumtaz Ali	Project administration	N/A