ORIGINAL RESEARCH

Application Value of Magnetic Resonance Imaging Medical Technology in the Perioperative Management of Brain Gliomas: Impact on Anesthesia and Prognosis

Jing Cui, MM; Lan Yao, BM; Changyu Lu, MD; Zongsheng Xu, BM; Lunxu Li, BM

ABSTRACT

Objective • To assess the utility of magnetic resonance imaging (MRI) medical technology in the perioperative management of brain gliomas and its impact on anesthesia and prognosis.

Methods • An observational, retrospective comparative study was conducted. We selected 60 patients who underwent glioma resection at our hospital from January 2019 to January 2020. Patients were divided into two groups based on admission order: the experimental group (EG) and the control group (CG), with 30 cases each. Patients in the CG underwent conventional intracranial tumor surgery, while those in the EG underwent supratentorial craniotomy for tumor resection with the assistance of MRI medical technology. We compared perioperative parameters, hemodynamic indices, tumor resection outcomes, postoperative complications, and postoperative physical function between the two groups.

Results • Compared to the CG, the EG had significantly longer surgery preparation time, anesthesia time, and surgery time ($P < .001$). However, there were no significant between-group differences in infusion volume and intraoperative blood loss ($P > .05$). Postoperative hemodynamic indicators were significantly higher in the EG than in the CG ($P < .001$), and postoperative tumor volume was markedly smaller in the EG ($P < .001$). The EG also achieved a significantly larger volume of tumor resection and a higher tumor resection rate ($P < .001$), a significantly lower total incidence of postoperative complications ($P < .05$), and notably higher Karnofsky Performance Status (KPS) scores ($P < .001$).

Conclusions • Compared to conventional intracranial tumor surgery, the utilization of MRI medical technology in brain glioma surgery, although it prolongs surgery and anesthesia times, enhances the tumor resection rate, and offers significant advantages in improving the prognosis of patients with brain glioma. (*Altern Ther Health Med.* 2023;29(8):482-488).

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INTRODUCTION

Gliomas, referred to as neurogliomas, are one of the most prevalent intracranial tumors encountered in clinical practice.[1] This disease constitutes a malignant neoplasm originating from glial cells stemming from the neuroectoderm. It can be initiated by a combination of congenital genetic high-risk factors, such as genetic mutations in high penetrance genes associated with rare syndromes and acquired environmental carcinogenic factors like exposure to high-dose electromagnetic radiation.[2]

Relevant data reveal that the incidence of primary malignant tumors of the central nervous system in the United States is approximately 7.2 per 100 000 people. Gliomas account for the majority of these, and their incidence has increased by 1.1% over the past 30 years.[2,3] According to published studies, the overall incidence of intracranial tumors in China is 31 per 100 000 people, with gliomas comprising 34.88% to 59.52%.[4,5] Gliomas can manifest at any age, but they are most frequently diagnosed in individuals aged 25 to 45 years.[6]

According to the 2016 World Health Organization (WHO) definitions, brain gliomas are categorized into four grades. Grades I and II fall under the classification of low-grade gliomas (LGG), while grades III and IV are considered high-grade gliomas (HGG).[7] LGG, while less malignant, has a propensity for malignant transformation. As a result, the preferred approach involves maximizing safe resection

whenever possible.[8] In contrast, HGG is characterized by its aggressiveness, a high rate of postoperative recurrence, and a poor prognosis. Currently, the primary treatment modality for HGG involves complete resection followed by postoperative chemoradiotherapy.[9]

Glioma resection serves several essential purposes, including the reduction of tumor load by decreasing tumor volume, the elimination of drug-resistant cells and tumor stem cells, and the enhancement of the effectiveness of subsequent radiotherapy and chemotherapy.[6-9] This procedure holds immense practical significance as it aids in the reduction of intracranial pressure, the amelioration of clinical symptoms, and the assurance of smooth progress in radiotherapy and chemotherapy.[8-9] Given the varying degrees of malignancy and diverse treatment approaches for gliomas, the accurate preoperative grading of these tumors becomes critically important. Such grading facilitates the evaluation of patients' conditions and plays a crucial role in selecting appropriate anesthetic agents and dosages, treatment regimens, and post-treatment follow-up management.

Magnetic resonance imaging (MRI) remains an important tool for preoperative grading and prognosis assessment of gliomas. It plays a fundamental role in guiding treatment decisions and plans, a significance confirmed in assessing cerebral conditions like tuberculous meningitis and neonatal hypoxic-ischemic encephalopathy.[10] Furthermore, MRI boasts high-resolution imaging capabilities for soft tissue alongside a remarkable degree of sensitivity and specificity. It enables multi-directional, multi-parametric, and multi-sequence imaging, effectively evaluating the outcomes of surgical resection. MRI holds substantial clinical diagnostic significance for correlating concurrent signs with surgery and quantifying the presence of residual tumors.

MRI has found applications in both pediatric and adult neurosurgery of the brain, demonstrating its effectiveness.[11] However, it is important to note that MRI can impact the surrounding environment and the patient's body. Strong magnetic fields, can induce electric effects, such as the generation of electrodynamic forces in blood within the magnetic field, leading to induced currents in tissue and subsequent hemodynamic fluctuations. Consequently, using MRI medical technology presents new challenges and imposes higher requirements on anesthesia management.

In light of these considerations, this study primarily explores the application value of MRI medical technology during the perioperative period of brain glioma surgery and its impact on anesthesia and patient prognosis. We conducted a comprehensive clinical investigation to provide a more robust evidence-based foundation for the care of such patients.

MATERIALS AND METHODS

Study Design and Patient Selection

An observational, retrospective comparative study was conducted, and 60 patients who underwent glioma resection and received treatment at our hospital between January 2019 and January 2020 were selected as the study participants. These patients were divided into the experimental group (EG) and the control group (CG), with 30 cases in each group. Ethical approval for this study was obtained from the hospital's ethics committee, and informed consent was obtained from the patients and their families. The study adhered to the principles outlined in the World Medical Association Declaration of Helsinki.[12]

Inclusion and Exclusion Criteria

Inclusion criteria were as follows: (1) patients were aged 18 years or older; (2) patients with a confirmed diagnosis of brain glioma based on Computed Tomography (CT), MRI, and other imaging examinations, along with pathological examination. Clinical symptoms included nausea, vomiting, optic neuropathy, and increased intracranial pressure; (3) patients with no prior history of intracranial surgery, hypertension, cardiovascular diseases, or cerebrovascular diseases; (4) patients did not exhibit severe language disorders, affective disorders, or disturbances of consciousness; (5) patients with no contraindications for MRI scans and intraoperative nerve electrophysiologic monitoring; (6) patients' physical status was classified as ASA class I-II according to the American Society of Anesthesiologists (ASA); (7) patients with primary brain glioma.

Exclusion criteria were as follows: (1) patients with a history of prior chemotherapy and radiotherapy; (2) patients who had a history of mental illness and had been on long-term psychotropic medication; (3) patients with a history of other systemic tumors; (4) patients with kidney and liver dysfunction; (5) patients with concurrent diseases that could interfere with this study, such as cardiac, renal, or liver dysfunction; (6) patients enrolled in other clinical trials.

Perioperative Intervention

Prior to surgery, patients underwent necessary preoperative examinations, and their vital signs were continuously monitored throughout the surgical procedure and during the postoperative period to minimize the risk of complications. Patients received comprehensive health education after surgery, and wound dressings were regularly changed to prevent incision infections. Our medical team maintained a quiet and comfortable ward environment to ensure optimal patient rest and sleep conditions. Additionally, patients were guided in performing appropriate rehabilitation exercises, encouraged to consume easily digestible foods, and advised to have multiple small meals to prevent digestive issues. Any complaints, such as headaches or discomfort, were promptly reported to the medical team for immediate attention and treatment.

Anesthesia Induction

Upon entering the operating room, both groups of patients underwent the following procedures.

Monitoring Vital Signs. Establishment of a peripheral venous channel in the upper extremity, radial artery cannulation, and the application of a magnetic resonance

(MR) special monitor (manufacturer: Philips Medical Technologies Co., Ltd.; Model: MP90). This monitor continuously tracked patients' vital signs, including electrocardiogram (ECG), non-invasive blood pressure, invasive blood pressure, pulse oxygen saturation, and heart rate (HR).

Anesthesia Administration. For anesthesia induction, the following medications were administered: (1) Cisatracurium (0.15 mg/kg; manufacturer: Zhejiang Xianju Pharmaceutical Co., Ltd.; NMPA approval No. H20090202; specification: 5 mg); (2) Midazolam (2 mg; manufacturer: Jiangsu Jiuxu Pharmaceutical Co., Ltd.; NMPA approval no. H20153019; specification: 3 ml: 15 mg); (3) Propofol (2-2.5 mg/kg; manufacturer: Fresenius Kabi Deutschland GmbH; Imported Drug License no. H20030124; specification: 50 ml/bottle); (4) Fentanyl (0.002-0.004 mg/kg; manufacturer: Langfang Branch, China National Pharmaceutical Industry Corporation Ltd.; NMPA approval no. H20123298; specification: 10 ml: 0.5 mg).

After tracheal intubation, mechanical ventilation was initiated using an MR-compatible anesthesia machine with the following parameters: (1) Tidal volume: 7-9 ml/kg; (2) Oxygen flow rate: 1 L/min; (3) FiO2: 60%; (4) Respiration ratio: 1:2; (5) Breathing frequency: 11-14 times/min; (6) Partial pressure of end-tidal carbon dioxide maintained at 31-34 mmHg.

Anesthesia Maintenance. Anesthesia maintenance involved a combination of intravenous and inhalation anesthesia: (1) Remifentanil (4-11 μg·h via IV; manufacturer: Jiangsu Nhwa Pharmaceutical Co., Ltd.; NMPA approval no. H20143314; specification: 1 mg); (2) Propofol (4-6 mg·h; manufacturer: Xi'an Libang Pharmaceutical Co., Ltd.; NMPA approval no. H19990282; specification: 20 ml: 200 mg).

EG - MRI-Guided Surgery

In EG, MRI scans were performed using the MAGNETOM Avanto model (manufacturer: Wittelsbacherplatz 2, DE-80333 Muenchen, Germany). During the resection of brain gliomas or tumors, if a portion of the tumor was in proximity to critical brain regions, MRI scans were utilized to address any brain shifts precisely. The surgery could be completed directly if no symptoms such as hydrocephalus or hematoma arose during tumor resection. In cases where complete tumor resection was not achieved, residual tumor areas were identified and marked using MRI, followed by subsequent resection until complete removal was achieved.

When the surgical procedure had been underway for approximately 35 minutes, an additional dose of 0.065-0.1 mg/kg of cisatracurium was administered. To ensure continuous anesthesia during the MRI scan, 1% sevoflurane (manufacturer: Shanghai Hengrui Pharmaceutical Co., Ltd., Shanghai, China; NMPA approval no. H20070172; specification: 120 ml) was administered via inhalation. Furthermore, throughout the surgery, efforts were made to minimize the exposure of the surgical incision. The volume of flushing fluid was carefully controlled, and room temperature was adjusted to align with the patient's body temperature. The use of anticholinergic medications was minimized, and sterile sheets were used to maintain a sterile surgical field.

At the completion of artificial dural repair, sevoflurane inhalation was promptly ceased. Simultaneously, the oxygen flow rate was increased to 3 L/min, and additional cisatracurium was administered. The infusion of propofol was terminated when the surgical team began suturing the skin, and the infusion of remifentanil was halted upon the completion of skin suturing. The endotracheal tubes were removed when patients exhibited the ability to breathe autonomously, responded to verbal cues by opening their eyes, demonstrated a return of the swallowing reflex, and were capable of performing simple movements. Subsequently, patients were transferred to the anesthesia recovery room for continuous monitoring once their vital signs had been stabilized.

CG – Conventional Surgery

Patients in the CG underwent conventional intracranial tumor surgery without using MRI technology. All other procedures remained consistent with those in the EG.

Observation Indicators

Perioperative Indicators. The following perioperative indicators were observed and recorded for both groups: (1) Surgery preparation time; (2) Surgery time; (3) Anesthesia time; (4) Infusion quantity; (5) Intraoperative blood loss.

Hemodynamic Indexes Monitoring. Hemodynamic indexes, including HR and Mean Arterial Pressure (MAP), were monitored for patients in both groups using an electrocardiogram monitor (manufacturer: Comen Medical Instruments Co., Ltd.; model: STAR8000E).

Tumor Volume and Resection. A comparison was made between the two groups for the following parameters: (1) Tumor volume before and after surgery; (2) Volume resected; (3) Tumor resection rate. Assessment of complete lesion resection was conducted before and after surgery by the imaging physician team. Lesion areas were outlined, and tumor volumes were calculated using the iPLAN software (version: 3.0; manufacturer: Brainlab company). Volume resected was determined as (preoperative volume - postoperative volume), and the tumor resection rate was calculated as (volume resected / preoperative volume) × 100%.

Postoperative Complications. The postoperative complications, including bradycardia, hypotension, and dyspnea, were observed and recorded for both groups.

Physical Status Evaluation. The physical status of the research subjects after treatment was evaluated using the Karnofsky Performance Scale (KPS).[13] The scale ranges from 0 to 100 points, with a higher score indicating better physical function in patients. Specific evaluation criteria can be found in Table 1.

Table 1. Scoring Criteria for Karnofsky Performance Scale (KPS)

Physical Status	Scores
Patients with normal activities, and no symptom or sign	100 points
Patients with normal activities, and minor symptoms and signs	90 points
Patients with reluctant normal activities and some symptoms and signs	80 points
Patients with the self-care ability and who could not maintain normal life and work	70 points
Patients with most self-care ability and who needed care occasionally	60 points
Patients who needed frequent care	50 points
Patients with little self-care ability and who needed special care and assistance in life	40 points
Patients without self-care ability	30 points
Patients with severe illness and who needed to cooperate with treatment in hospital actively	20 points
Patients with critical illness and near death	10 points
Death	0 point

Note: The Karnofsky Performance Scale (KPS) assesses a patient's functional status and ranges from 0 to 100, with higher scores indicating better functional status. The criteria in this table outline the scoring for various levels of physical status.

Table 2. Between-group comparison of baseline data

Item	EG (n = 30)	CG (n = 30)	χ^2/t	*P* value
Gender			0.318	.573
Male	22 (73.33%)	20 (66.67%)		
Female	8 (26.67%)	10 (33.33%)		
Age (±s, years)	55.97±10.83	59.77±9.15	1.468	.148
BMI (±s, kg/m^2)	20.55±0.31	20.53±0.32	0.246	.807
Course of disease (±s, months)	12.03±2.04	11.17±1.86	1.706	.093
Tumor size (±s, cm)	4.43±0.95	4.54±0.90	0.460	.647
Brain Glioma Grade			0.067	.795
High	17 (56.67%)	16 (53.33%)		
Low	13 (43.33%)	14 (46.67%)		
Occupation				
Civil servant	8 (26.67%)	9 (30.00%)	0.082	.774
Teacher	7 (23.33%)	8 (26.67%)	0.089	.766
Accountant	6 (20.00%)	5 (16.67%)	0.111	.739
Farmer	4 (13.33%)	3 (10.00%)	0.162	.688
Worker	3 (10.00%)	3 (10.00%)	0.000	1.000
Others	2 (6.67%)	2 (6.67%)	0.000	1.000
Educational Degree				
Primary school and junior high school	11 (36.67%)	10 (33.33%)	0.073	.787
Senior high school and junior college	10 (33.33%)	12 (40.00%)	0.287	.592
College and above	9 (30.00%)	8 (26.67%)	0.082	.774
Religious Faith			0.067	.795
Yes	13 (43.33%)	14 (46.67%)		
No	17 (56.67%)	16 (53.33%)		
Family Income Situation			0.077	.781
≥3000 yuan/(month /person)	20 (66.67%)	21 (70.00%)		
<3000 yuan/(month /person)	10 (33.33%)	9 (30.00%)		
Place Of Residence			0.089	.766
Urban Area	22 (73.33%)	23 (76.67%)		
Rural Area	8 (26.67%)	7 (23.33%)		

Note: Values are presented as counts (percentages) for categorical variables and mean ± standard deviation ($\bar{x} \pm s$) for continuous variables. The significance of between-group differences was assessed using the chi-square test (χ^2) for categorical variables and the *t* test (*t*) for continuous variables, with statistical significance set at $P < .05$.

Abbreviations: CG, Control Group; EG, Experimental Group.

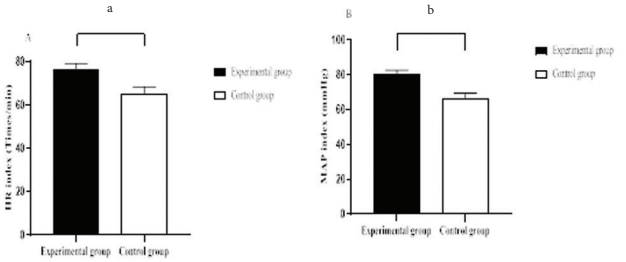
Table 3. Between-group comparison of perioperative indicators ($\bar{x} \pm s$)

Group	n	Surgery Preparation Time (min)	Anesthesia Time (min)	Surgery Time (min)	Infusion Quantity (ml/kg·h)	Intraoperative Blood Loss (ml)
EG	30	44.63 ± 3.09	381.83 ± 25.39	510.55 ± 34.24	6.94 ± 0.41	533.08 ± 29.89
CG	30	14.90 ± 0.59	302.94 ± 17.26	347.41 ± 27.07	6.97 ± 0.49	523.12 ± 15.52
t		51.763	14.074	20.472	0.257	1.619
P value		<.001	<.001	<.001	.798	.111

Note: Values are presented as mean ± standard deviation ($\bar{x} \pm s$). The significance of between-group differences was assessed using the *t* test (*t*) for continuous variables, with statistical significance set at $P < .05$.

Abbreviations: CG, Control Group; EG, Experimental Group.

Figure 1. Between-group comparison of hemodynamic indexes ($\bar{x} \pm s$).



[a]indicated an obvious difference between groups in postoperative HR index ($t = 14.166$, $P < .001$).
[b]indicated an obvious difference between groups in postoperative MAP index ($t = 19.992$, $P < .001$).

Note: Figure A shows the comparison of postoperative HR index between the two groups; the horizontal axis indicated EG and CG, and the vertical axis indicated HR index (times/min); The HR indexes of EG and CG were respectively (76.27 ± 2.88) and (65.00 ± 3.27); Figure B shows the between-group comparison of postoperative MAP index; the horizontal axis indicates EG and CG, and the vertical axis indicates MAP index (mmHg); The MAP indexes of EG and CG were respectively (80.33 ± 2.32) and (66.43 ± 3.02)

Statistical Analysis

In this study, data analysis utilized Statistical Product and Service Solutions (SPSS) version 20.0 (IBM, Armonk, NY, USA). Graphs were generated using GraphPad Prism 7 (GraphPad Software, San Diego, CA, USA). Data included both categorical and continuous variables. Statistical methods employed in this study involved the χ^2 test, *t* test, and normality test. Statistically significant differences were defined at a significance level of $P < .05$.

RESULTS

Comparison of Baseline Data between Groups

Table 2 illustrates that no statistically significant differences between the groups were observed for variables including gender, age, body mass index (BMI), disease duration, tumor size, brain glioma grade, occupation, educational level, religious affiliation, family income, or place of residence ($P > .05$).

Comparison of Perioperative Indicators between Groups

Compared to CG, the EG exhibited significantly longer surgery preparation time, anesthesia time, and surgery time ($P < .001$). There were no notable differences between the two groups in terms of infusion quantity and intraoperative blood loss ($P > .05$). Refer to Table 3 for details.

Comparison of Hemodynamic Indexes between Groups

Figure 1 illustrates that postoperative hemodynamic indexes were significantly higher in EG compared to the CG ($P < .001$).

Comparison of Tumor Volumes, Volumes Resected, and Resection Rates

Table 4 indicates that, in comparison to CG, EG achieved a notably reduced postoperative tumor volume ($P < .001$)

and significantly larger volume resected, resulting in a higher tumor resection rate ($P < .001$).

Comparison of Postoperative Complications between Groups

Table 5 demonstrates that the overall incidence of postoperative complications was significantly lower in EG than in CG ($P < .05$).

Comparison of KPS Scores between Groups

Table 6 reveals that the KPS score was substantially higher in EG than in CG ($P < .001$).

DISCUSSION

Brain glioma, a common primary intracranial tumor, can be attributed to factors such as ionizing radiation, heredity, and environmental influences. Epidemiological studies have revealed that brain gliomas predominantly affect individuals aged 25-45 years. Unfortunately, patients with brain glioma face a median survival time of just 14.6 months, and their 5-year mortality rate ranks second only to that of lung and pancreatic cancer among systemic tumors.[10-14] In clinical practice, surgery is the typical approach for treating glioma patients. While surgical outcomes are generally favorable, the postoperative prognosis is intricately linked to factors such as tumor pathological grade, the extent of surgical resection, and the selection and dosage of anesthetic drugs.[14]

Related experimental studies have shown that, in patients undergoing glioma surgery, the observed enhancing areas on MRI scans frequently indicate the presence of malignant gliomas. Surgical resection, being a form of mechanical invasive procedure, can induce stress reactions in the normal brain tissue surrounding the surgical site. It can lead to physiological or pathological changes, often resulting in the appearance of reactive enhancement when postoperative MRI scans are reviewed.[8,15]

Relevant published studies have highlighted the challenges in distinguishing the boundary between brain gliomas and normal brain tissue. Brain gliomas exhibit aggressive growth patterns, often making complete surgical resection difficult to achieve. In traditional craniotomy procedures, tumor boundary delineation primarily relies on the surgeon's experience, leading to a higher incidence of postoperative neurological deficits in patients. In contrast, intraoperative imaging offers an effective means of objective assessment, providing valuable data and information for better intraoperative quality control compared to conventional judgment.[16,17]

Intraoperative MRI technology represents a novel neuroimaging approach that primarily utilizes MR contrast to detect hemodynamic changes associated with neuronal activity. It offers perioperative intracranial imaging capabilities, ranging from low to high field strengths and from fixed to movable magnets. This technology encompasses structural and functional imaging, enabling the study of cerebral cortex activity. As a result, it has emerged as a highly innovative area of interest in the field of minimally invasive surgery.[18]

Table 4. Comparison of Tumor Volumes, Volumes Resected, and Resection Rates Between Groups ($\bar{x} \pm s$)

Group	n	Preoperative Tumor Volume (cm^3)	Postoperative Tumor Volume (cm^3)	Volume Resected (cm^3)	Tumor Resection Rate (%)
EG	30	39.18 ± 2.67	0.74 ± 0.09	38.44 ± 2.67	98.11 ± 0.25
CG	30	39.19 ± 2.48	5.66 ± 0.42	33.53 ± 2.66	85.48 ± 1.66
t		0.015	62.738	7.136	41.208
P value		.988	<.001	<.001	<.001

Note: The values are presented as means ($\bar{x} \pm s$) with standard deviations (s). Statistical analysis reveals significant differences between EG and CG in postoperative tumor volume, volume resected, and tumor resection rate ($P < .001$).

Abbreviations: CG, Control Group; EG, Experimental Group.

Table 5. Comparison of Postoperative Complications Between Groups [n(%)]

Group	n	Bradycardia	Hypotension	Dyspnea	Total Incidence Rate
EG	30	1 (3.33%)	1 (3.33%)	1 (3.33%)	3 (3.3%)
CG	30	3 (10.00%)	2 (6.67%)	4 (13.33%)	10 (33.33%)
χ^2					4.812
P value					<.05

Abbreviations: EG, Experimental Group; CG, Control Group; n, Sample Size.

Table 6. Comparison of KPS Scores between groups ($\bar{x} \pm s$)

Group	n	KPS Score
EG	30	78.43 ± 5.20
CG	30	56.40 ± 3.75
t		18.821
P value		<.001

Abbreviations: EG: Experimental Group; CG: Control Group; n: Sample Size; KPS: Karnofsky Performance Scale.

It is widely recognized that medical techniques like MRI hold significant diagnostic value in various conditions, including gastric cancer, kidney cancer, gliomas, lymphomas, and other brain tumors such as schwannomas, meningiomas, cerebellar angioreticulomas, and cerebellar astrocytomas.[19] While enhancing the precision of diagnosis and localization, the utilization of MRI technology also presents novel challenges in the field of neurosurgical anesthesia management, ultimately influencing the evolution of both surgery and anesthesia.

Previously, most studies focused on reporting the impact of MRI in aiding brain surgery and its therapeutic effects on surgical resection, with limited attention given to the influence of MRI techniques on anesthesia. Our study's findings revealed that, compared to the CG, the EG exhibited significantly longer surgery preparation time, anesthesia time, and surgery time ($P < .001$). However, the two groups had no notable differences regarding infusion quantity and intraoperative blood loss ($P > .05$).

This discrepancy may stem from the fact that the application of MRI techniques in brain glioma resection requires extended time for preparation and anesthesia, owing to the multiple MRI scans involved. However, the combination of intravenous and inhalation anesthesia administered during the surgery offers several advantages, including prevention of intraoperative awareness, rapid onset, and effective pain relief.[20] This approach ensures absolute anesthesia during

MRI procedures, ensuring the smooth progression of surgery. Furthermore, the study findings indicated that hemodynamic indexes were significantly higher in the EG compared to the CG ($P < .001$). This finding suggests that the intraoperative use of MRI can lead to more pronounced hemodynamic fluctuations in patients.

Prolonged anesthesia can induce stress responses, and the human body's blood, being an efficient electrical conductor, generates electrical potential, especially in high-field strength or resting environments. Additionally, body tissues can generate induced currents, triggering cardiac activity when reaching a certain threshold. Consequently, significant alterations in hemodynamics may occur following MRI scans.

Furthermore, the study results demonstrated that in comparison to the CG after surgery, the EG exhibited significantly smaller tumor volume ($P < .001$), substantially larger volume resected, and a higher tumor resection rate ($P < .001$). Additionally, EG had a significantly lower total incidence rate of postoperative complications ($P < .05$). These findings provide robust evidence that the application of MRI technology in brain glioma resection effectively enhances the tumor resection rate while maintaining a higher level of safety. Consequently, the surgical efficacy of MRI medical technology in brain glioma resection deserves recognition and affirmation.

Intraoperative MRI technology facilitates the real-time visualization of the tumor's proximity to crucial fiber tracts.[21] It allows assessing tumor grade based on changes in cortical fiber tract morphology, enabling the precise design of surgical pathways to define the location and boundaries of brain gliomas.[22] Therefore, this approach maximizes the extent of glioma resection while preserving brain nerve function, effectively reducing the risk of permanent postoperative functional deficits in patients. However, it is worth noting that the requirement for multiple scans extends the overall surgery time. Therefore, it demands detailed oversight from an anesthesiologist to maintain the intraoperative balance of various physiological indicators.[23]

The KPS score is widely used for evaluating functional status. A KPS score of ≥ 80 indicates that patients have the ability to self-care, while a KPS score of ≥ 70 signifies a good postoperative status for patients in clinical settings.[24] In this study, the KPS score was significantly higher in the EG than in the CG ($P < .001$). These findings robustly demonstrate that the application of MRI medical technology in brain glioma surgery effectively enhances patient outcomes, thereby expediting rehabilitation.

Study Limitations

Firstly, this study was conducted within a specific local population and did not include enough patients from other provinces or nationalities. Therefore, the results may be influenced by the small sample size, regional cultural variations, and ethnic differences. Secondly, patient evaluations were based on scale assessments, introducing an element of subjectivity and intention in their responses, which could have influenced the outcomes of the clinical trials. Lastly, variations in medical staff expertise, MRI examination, and perioperative histopathologic evaluation techniques might have introduced some degree of variability in the study's results.

Future studies should consider increasing the sample size and conducting multicenter studies to arrive at more precise conclusions. Despite the continuous advancement of modern medical technology, challenges persist in diagnosing and treating brain gliomas. Therefore, medical professionals must continue to explore more efficient diagnostic and treatment methods to benefit patients and overcome current clinical challenges.

CONCLUSION

In conclusion, this study highlights the significant advantages of incorporating MRI medical technology during brain glioma surgery. The application of MRI enables precise tumor localization, maximizes resection while preserving vital brain functions, and ultimately leads to improved patient outcomes, as evident in the higher Karnofsky Performance Scale scores. However, it is important to acknowledge the limitations stemming from a localized sample and subjective patient assessments. Future research studies should focus on expanding the sample size and conducting multicenter studies to enhance the generalizability of these findings. In the quest to address the persistent challenges in brain glioma diagnosis and treatment, the integration of advanced medical technologies remains a promising avenue for improving patient care.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

AUTHORS' CONTRIBUTIONS

JC and LL designed the study and performed the experiments; LY and CL collected the data; LY, CL, and ZX analyzed the data; JC and LL prepared the manuscript. All authors read and approved the final manuscript.

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