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Pediatric Brain Tumors: Surgical Approaches and Long-Term Neurocognitive Outcomes

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Abstract: With an incidence in around 3/100,000 children, pediatric brain tumors represent the most frequent hard tumors that cause morbidity and mortality in children worldwide. The objective of this study is to evaluate the role of surgical techniques in the treatment of pediatric brain tumors, to assess health-related quality of life, and to determine neurocognitive outcomes. A comprehensive data set encompassing demographic and clinical parameters was meticulously collected from 120 pediatric patients diagnosed with brain tumors across multiple hospitals in Basrah, Iraq. The study's inclusion criteria were limited to patients aged 2–16 years. The patient data were obtained from the hospitals, including demographics (age, sex, BMI, etc.), diagnostics (tumor location and type), and surgical outcomes. Complications and pain experienced by the patients were meticulously documented, and quality-of-life assessments were conducted using the SF-36 questionnaire. The present study enrolled clinical outcomes of 120 samples of pediatric brain tumors. The analysis revealed that the most prevalent clinical outcomes were headache (43.33%) and nausea/vomiting (25%), with tumor location in the posterior fossa (41.67%) and parietal bone (20.83%) being significant. The surgical approach was predominantly elective (88.33%), indicating a preference for surgical intervention. All patients underwent surgical resection in different hospitals during follow-up. Post-surgical complications occurred in 65% of patients, neurological complications in 22.5%, surgical site infections in 14.17%, and mortality in 13.33%. Surgical resection is the most common procedure for acute cases of pediatric brain tumors in terms of mortality rates and quality of life complications.

Keywords: Pediatric; Brain tumors; Symptoms; Surgical resection; Complications, SF-36 Questionnaire.

Introduction

Brain tumors represent the most prevalent neoplasms in childhood, second only to leukemias [1]. On a global scale, they constitute the foremost cause of cancer-related mortality in children. [2]

The incidence of brain tumors among children under 19 years of age ranges from 1 to 3 cases per 100,000 individuals, with a higher rate of 5.4 per 100,000 when including benign tumors [3,4]. A distinct pattern of tumor distribution emerges with age: supratentorial tumors are more prevalent in children younger than three years and older than ten, while infratentorial tumors are more common between four and ten years of age [5]. It is noteworthy that 45-60% of children's brain tumors are located in the posterior fossa. Tumors of embryonic origin are more prevalent in younger children, while those of glial origin predominate in older children. [6]

The etiology of most childhood brain tumors remains unknown. It is noteworthy that up to 8% of childhood and adolescent cancers are attributable to genetic syndromes. Exposure to ionizing radiation has been identified as the sole environmental risk factor that has been consistently associated with the development of brain tumors in childhood. [7,8,9]

The 2007 classification of central nervous system (CNS) tumors by the World Health Organization (WHO), which was based exclusively on histological characteristics, has since been superseded by the 2016 classification, which incorporates molecular and genetic parameters [10,11]. These advancements have been made possible thanks to high-resolution genomics, epigenetics, and transcriptomics studies. These advancements have paved the way for the development of targeted therapies, particularly for gliomas, and the more precise stratification of risk groups, such as medulloblastomas and ependymomas. [12,13,14]

Patients and Methods

We conducted a cross-sectional study of 120 pediatric patients with brain tumors who were diagnosed and underwent surgery in different hospitals in Basrah, Iraq, during a one-year follow-up period from January 2023 to January 2024. All pediatric patients with brain tumors, aged 2 to 16 years, both male and female, underwent surgery. Patient demographics were recorded during the follow-up period, including age, body mass index (BMI), gender, symptoms, tumor size, and other parameters of parental socioeconomic status.

For admission and discharge parameters, only pediatric patients aged 2 to 16 years, some of whom were obese, completed a quality-of-life questionnaire, and some of whom were admitted to the hospital emergency department were included. Adult patients were excluded, as were patients with anemia, other genetic or dermatologic diseases, and patients who did not complete the questionnaire. All patients were diagnosed, and data were collected on symptoms and tumor location, type, and size. Some patients were admitted to the emergency room or underwent elective resection.

For surgical resection, all intraoperative and postoperative data were recorded, including duration of surgery, hospital stay, mortality rate, and survival life period, number of patients with intraoperative bleeding, pain, and complications related to pediatric brain tumors during short- and long-term follow-up. In addition, a comprehensive questionnaire was administered to assess the general health of pediatric patients after surgery to determine the positive and negative aspects of the procedure.

The questionnaire included the SF-36 quality of life scale with a range of 0 to 100, with higher scores representing optimal patient outcomes and lower scores representing inferior outcomes. All patient data were analyzed and recorded, and quality of life was assessed using the S BSS 22.0 software.

Results

This study enrolled data of a total of 120 patients of children with brain tumors. A group aged (2 – 8) were the most prevalence by brain tumors, including 70%, where females (44.17%) got high rate than males (55.83%), Tumor volume was 36.0 ± 3.0 mL, duration between symptoms onset and surgery had 53 ± 11 days, and hydrocephalus with 62.5%.

Table 1. Demographic characteristics of patients.

Parameters	Patients {n = 120}	Percentage, {%}
Age		
2 – 8	84	70%
9 – 16	36	30%
Gender		
Male	53	44.17%
Female	67	55.83%

BMI, {kg/m2}		
Normal	78	65%
Obesity	42	35%
Duration between symptoms onset and surgery {days}	53 ± 11	
Tumor volume {mL}	36.0 ± 3.0	
Hydrocephalus		
Yes	75	62.5%
No	45	37.5%
Marital status of parents		
Married	84	70%
Divorced	24	20%
Widow	12	10%
Economic status of parents, $		
< 400	60	50%
400 – 700	36	30%
> 700	24	20%

We noticed the high widely of brain tumor symptoms in pediatrics, where the most common headache with 43.33%, and nausea/vomiting with 25%. The most prevalence of brain tumor sites had posterior fossa and parietal bone, 41.67% and 20.83%.

Table 2: Distribution symptoms of brain tumor in pediatrics.

Symptoms	Patients {n = 120}	Percentage, {%}
Headache	52	43.33%
Nausea/vomiting	30	25%
Motor weakness	16	13.33%
Vision problems	15	12.5%
Gait problems	11	9.17%
Grand nerve palsies	6	5%
Recurrent seizures	5	4.17%
Disturbed consciousness	3	2.5%
Others	2	1.67%

Table 3: Distribution of the brain tumor site in pediatrics.

Brain tumor site	Patients {n = 120}	Percentage, {%}
Posterior fossa	50	41.67%
Parietal bone	25	20.83%
Temporal lobes	9	7.5%
Orbit	6	5%
Brain stem	13	10.83%
Supra seller	4	3.33%
Pituitary	5	4.17%
Others	8	6.67%

The current outcomes of children had 50% of occipital and 23.33% of supratentorial, where 88.33% underwent to surgical resection electively.

Table 4: Determining surgical approach of brain tumor.

Surgery approach	Patients {n = 120}	Percentage, {%}
Occipital	60	50%
Supratentorial	28	23.33%
Temporoparietal	23	19.17%
Frontal	6	5%
Retrosigmoid	3	2.5%

Table 5: Mode of surgery.

Mode of surgery	Patients {n = 120}	Percentage, {%}
Elective	106	88.33%
Emergency	14	11.67%

Surgical outcomes enrolled duration of operation had 3.28 ± 1.44, 13 cases had intraoperative bleeding, length of stay in hospital was 7.5 ± 2.9, ICU admission had 12.5%, mortality rate was 13.33%, 65% of patients had complications after surgery, where neurological (22.5%) and surgical site infection (14.7%), delay in postoperative management due to surgical site infection was 70% in short – term complication, while seizure disorder and movement disorder, 25.83%, 18.33% in long – term complications.

Table 6: Surgical outcomes of surgical resection.

Variables	Patients {n = 120}	Percentage, {%}
Length of surgery (hours)	3.28 ± 1.44	
No. of bleeding	13	10.83%
Length of in-hospital stay (days)	7.5 ± 2.9	
ICU admission		
Present	15	12.5%
Absent	105	87.5%
Overall survival time (months)	12.4 ± 1.5	
Progression-free survival time (months)	9.7 ± 1.2	
Mortality rate		
Yes	16	13.33%
No	104	86.67%
Postsurgical complications	**78**	**65%**
Neurological	27	22.5%
Surgical site infection	17	14.17%
Deep	17	14.17%
Superficial	0	0%
Electrolytes imbalance	8	6.67%
Endocrinological	7	5.83%
Postoperative hematoma	7	5.83%
cerebrospinal fluid leak	6	5%
Posterior fossa syndrome	6	5%
Delay in postoperative management due to SSI		
Present	84	70%
Absent	36	30%
Long-term disadvantages		
Seizure disorder	31	25.83%
Movement disorder	22	18.33%
Electrolytes imbalance	12	10%
Other endocrine deficits	9	7.5%

Vision problems	8	6.67%
Hypothyroidism	5	4.17%
Cerebellar mutism	4	3.33%
Growth hormone deficiency	3	2.5%
Cognitive disorders	2	1.67%

All patients were conducted into a general health quality of life questionnaire, which is called SF – 36, where it found lowest scores of quality of life in emotional function with 43.85 ± 5.67 and daily activity (50.20 ± 9.62), while high scores of quality–life in both of physical function (62.13 ± 7.51) and eating (68.31 ± 7.99).

Table 7: Assessment of general health quality – life at patients by SF – 36 questionnaire.

Items	SF – 36 scores
Physical function	62.13 ± 7.51
Psychological function	58.66 ± 8.72
Pain	54.94.13.80
Fatigue	67.53 ± 6.90
Emotional function	43.85 ± 5.67
Daily activity	50.20 ± 9.62
Eating	68.31 ± 7.99
Walking	53.17 ± 7.98

Discussion

This is in line with different research that found that there are five brain tumors along with pediatric cancers for each 100,000 individuals [15]. Compared to other pediatric malignancies, brain tumors are thought to be the leading cause of death in children, where solid tumors are most prevalent. On the other hand, childhood brain cancer ranks second for the United States [16]. Consistent with the findings of a prior investigation, the current study's findings demonstrated that brain cancer among children occurs nearly differently in boys (44.17%) than in girls (55.83%). This is in contrast to another study that found that males were more likely than females to have the condition .

Our research's higher prevalence with brain cancer among children in the 2–8 age range contradicts with a Canadian study [17] that found the illness is more common in infants under three years old. With few exceptions, features of children such as gender and age are not related to the vulnerability to brain tumors. The clinical symptoms reported in children with brain cancer are exactly the same as those reported in previous studies. The latest study's findings about the location of brain tumors in children are in line with earlier research that found that the posterior fossa with parietal bone are the most common sites for brain tumors in children, with 41.67% and 20.83% of cases, respectively. [18]

Based on previous studies, gliomas and other neuroepithelial tumors are quite common in baby brain tumors, occurring at an incidence rate of 1.16 per 100,000 persons annually [19]. Despite the lack of histological differentiation between adult and pediatric glial tumors, there have been notable changes in epidemiology; glioblastoma is a very common glioma in maturities, with an incidence rate of 3.19 per 100,000 persons per year, while infantile pilocytic-astrocytoma is the most common glioma in infants, with an incidence rate of 0.8 per 100,000 persons per year . [20,21]

Our study's intriguing conclusion was that the length of time between the start of symptoms and surgery significantly influenced the risk of SSI. Notably, the incidence of SSIs was lower in those who experienced symptoms for a longer period of time before to operation (80 days) [22,23,24]. High-grade tumors can cause hydrocephalus to develop and appear early. In a similar

vein, patients with worse survival rates also showed a shorter time between symptoms and operation. [25]

Conclusion

Although it is the most common surgical resection performed for pediatric patients with brain tumors, our study demonstrated a mortality rate of 13.33% for pediatric patients and a 65% high complication rate, which significantly impacts children's quality of life. Therefore, this study confirmed that age, duration of symptoms at the time of surgery, and the presence of hydrocephalus significantly impacted surgical outcomes, contributing to the high complication rate in patients.

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