Original Article

Cukurova Anestezi ve Cerrahi Bilimler Dergisi

Pediatric Neuroblastoma: Survival, Mortality, and Surgical Outcomes at a Tertiary Care Center

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Abstract

Introduction: This retrospective study aimed to describe the clinical, pathological, demographic, surgical, and outcome characteristics of pediatric neuroblastoma patients treated in a tertiary healthcare center. **Materials and Methods:** This retrospective study was conducted using the medical records of pediatric patients diagnosed with and followed up for neuroblastoma at the Pediatric Hematology-Oncology Department of Van Yüzüncü Yıl University Dursun Odabaş Medical Center between January 1, 2010, and April 25, 2025. Descriptive statistics were used to summarize the data. Continuous variables were presented as median and interquartile range (IQR), while categorical variables were presented as numbers and percentages. **Results:** A total of 20 pediatric neuroblastoma cases were included. The median age at diagnosis was 3.0 years (IQR 1.33–3.88). 55% had stage 4 disease, 40% had stage 3, and 5% had stage 1. 70% were high-risk, 25% intermediate-risk, and 5% low-risk. During follow-up, 50% of patients died and 40% experienced recurrence. Surgical resection was performed in 95%, with adrenalectomy being the most common procedure. **Conclusion:** High-stage and high-risk groups predominate among pediatric neuroblastoma patients followed at our center, and mortality and recurrence are more frequent in this group. Our data highlight the importance of early diagnosis, multidisciplinary treatment, and appropriate surgical management.

Keywords: Neuroblastoma; Oncology; Chemotherapy; Mortality; Surgery

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1. Introduction

Neuroblastoma is the most common extracranial solid tumor in children under five years of age and accounts for approximately 15% of childhood cancer-related deaths[1]. More specifically, neuroblastoma is thought to originate from sympathetic adrenal progenitor cells that first appear in the sympathetic ganglia and adrenal glands during development[2]. The biological behavior of this tumor is unpredictable and can range from slowly progressing disease with spontaneous regression to rapidly progressing metastatic cancer[3].

Neuroblastoma is usually diagnosed in the first years of life and represents one of the leading causes of cancer-related deaths in infancy and early childhood. Its outcomes

vary depending on patient age, disease stage, histological features, and genetic alterations, particularly MYCN amplification[4]. In addition to genetic and biological factors, maternal drug use and environmental factors, as well as prenatal and perinatal exposures, are also thought to contribute to the etiology of neuroblastoma[5].

Neuroblastoma treatment is determined according to risk classification and generally involves a multimodal treatment approach including chemotherapy, surgery, radiotherapy, and immunotherapy[6]. In high-risk neuroblastoma, treatment usually requires an intensive multimodal approach including induction chemotherapy, surgical resection, radiotherapy, stem cell transplantation, and maintenance therapy[7]. Recent studies have reported that event-free survival is approximately 20%, while overall survival is around 30% in patients with recurrent or refractory high-risk neuroblastoma[8].

The primary goal in neuroblastoma surgery is to achieve as complete resection of the tumor as possible without damaging surrounding organs[9]. In a study conducted by Fischer et al., 85% of tumors could be removed surgically[10]. This descriptive retrospective study aimed to characterize the clinical, pathological, demographic, surgical, and outcome features of pediatric neuroblastoma patients treated in a tertiary care setting.

2. Materials and Methods

This single-center, retrospective descriptive case series was conducted using the medical records of pediatric patients diagnosed with neuroblastoma and followed up at the Pediatric Hematology-Oncology Department of Van Yüzüncü Yıl University Dursun Odabaş Medical Center between January 1, 2010, and April 25, 2025. Patients aged 0–18 years with a pathologically confirmed diagnosis of neuroblastoma were included. Patients with incomplete data or those who dropped out of follow-up were excluded.

Demographic and clinical data were recorded, including gender, age at diagnosis, International Neuroblastoma Staging System (INSS) stage, risk group, bone marrow involvement, recurrence status, MYCN amplification status, treatment regimen, survival time, and mortality. Histopathological evaluation was performed according to the International Classification of Neuroblastoma Pathology (Shimada system), and tumors were classified as favorable or unfavorable histology[10]. Surgical data including type of procedure and frequency of resection were obtained from surgical records and patient files.

Descriptive statistics were used to summarize the data. Continuous variables were presented as median and interquartile range (IQR), while categorical variables were presented as numbers and percentages. Statistical analyses were performed using IBM SPSS Statistics version 25.0.

Ethical approval was obtained from the Van Yüzüncü Yıl University Non-Interventional Ethics Committee (Approval No: 2025/04-29). The study was conducted in accordance with the Declaration of Helsinki. Informed consent was waived due to the retrospective design.

3. Results

A total of 20 pediatric neuroblastoma patients were included. Twelve patients (60%) were girls and eight patients (40%) were boys. The median age at diagnosis was 3.0 years (IQR: 1.33–3.88; range: 0.16–13 years). The most common primary tumor site was the adrenal gland, observed in 18 patients (90%). One patient (5%) had cervical vertebral involvement and one patient (5%) had thoracic vertebral involvement.

According to the International Neuroblastoma Staging System, 11 patients (55%) were diagnosed with stage 4, eight patients (40%) with stage 3, and one patient (5%) with stage 1. Histopathological evaluation revealed unfavorable histology in 13 patients (65%) and favorable histology in seven patients (35%). Fourteen patients (70%) were classified

as high-risk, five (25%) as intermediate-risk, and one (5%) as low-risk. MYCN amplification was detected in nine patients (45%).

Bone marrow involvement was present in 7 patients (35%), absent in 12 patients (60%), and unknown in one patient (5%). Metastatic disease was observed in 12 patients (60%), most frequently affecting the bone and/or bone marrow. Details of the metastatic distribution are presented in Table 1.

Table 1. Distribution of metastatic sites in pediatric neuroblastoma patients (N = 20)

Region	n	%
Lung + bone marrow	2	10
Lung + bone marrow + other	1	5
Bone marrow	3	15
Bone alone (without bone marrow)	3	15
Bone marrow + vertebra	1	5
Lymph nodes + adjacent soft tissues	1	5
Vertebra alone	1	5
Total	12	60

Note: Values are presented as number and percentage of the total study population.

Surgical treatment was performed in 19 patients (95%), with adrenalectomy being the most common procedure (n = 16). Detailed information regarding surgical interventions is presented in Table 2.

Table 2. Surgical procedures performed in pediatric neuroblastoma patients (N = 20)

Surgical Intervention	n	%
Adrenalectomy alone	16	80
Vertebra surgery	1	5
Spinal surgery	1	5
Thoracic vertebra surgery	1	5
No surgery performed	1	5
Total	20	100

Note: Values are presented as number and percentage of the total study population.

Chemotherapy was administered to all but one patient. The most frequently used protocol was TPOG NB alone or in combination with other agents. Immunotherapy was administered to four patients (20%). Radiotherapy was performed in two patients for lung and spinal lesions, respectively.

During the follow-up period, relapse occurred in eight patients (40%), while 12 patients (60%) did not experience relapse. Death was observed in 10 patients (50%), eight patients (40%) were alive at the last follow-up, and outcome data were unavailable for two patients (10%). Morbidity was reported in two patients (10%). The median survival time was 2 years (IQR: 0–5.75; range: 0–13 years). Four patients were still receiving treatment at the time of data collection.

4. Discussion

In this study, the clinical, histopathological, surgical, and prognostic characteristics of 20 pediatric patients diagnosed with neuroblastoma were retrospectively evaluated. The most frequent primary tumor localization was the adrenal gland (90%). The literature also reports that approximately 40–50% of neuroblastomas originate from the adrenal medulla, and that tumors can arise in different regions along the sympathetic nervous system[3,11].

More than half of the patients (55%) were diagnosed with stage 4 neuroblastoma. The literature reports that a significant proportion of children present with metastatic disease at diagnosis, especially in high-risk or advanced-stage patients, with metastases to bone,

bone marrow, and distant organs. The high recurrence and mortality rates in stage 4 patients in our study reflect the aggressive biological behavior of advanced neuroblastoma and limited survival rates despite current treatment approaches[3,7].

Histopathological evaluation revealed unfavorable histology in 65% of cases, paralleling the predominance of high-risk classification in 70% of patients. The literature also reports a strong association between unfavorable histology and high-risk neuroblastoma[3]. Furthermore, MYCN amplification was detected in 45% of cases in our study. MYCN amplification is known to occur in approximately 20–30% of neuroblastoma cases and is associated with aggressive tumor behavior[7]. The higher rate in our study may be due to the referral of patients with advanced stage and unfavorable prognostic features to our center.

Bone marrow involvement was detected in 35% of patients, consistent with previously reported metastatic studies of neuroblastoma, where bone marrow is one of the most common sites of metastasis[7,12]. Recurrence occurred in 40% of patients, and high recurrence rates have also been reported in studies focusing on high-risk neuroblastoma populations[13].

Analysis of chemotherapy regimens showed that the TPOG NB protocol was the most frequently used, followed by intensified treatment approaches such as ICE and anti-GD2-based immunotherapy. Yu et al. demonstrated improved survival associated with anti-GD2 immunotherapy, particularly in high-risk and relapsing patients. However, due to limited resources, only four patients in our study were able to receive this treatment[14].

The vast majority of patients (95%) underwent surgical treatment, with adrenalectomy being the most frequently performed procedure. The literature reports that surgery plays an important role in neuroblastoma treatment, and that the widest possible resection of the primary tumor is aimed for, especially in localized disease[7,9].

We found that 40% of patients experienced relapse and 50% experienced mortality during follow-up. The literature reports that relapse is frequent in high-risk neuroblastoma patients despite intensive multimodal treatment, and that survival is quite limited in patients who relapse, with average survival generally less than two years. The relapse and mortality rates obtained in our study appear consistent with results reported in the literature[15,16,17].

Limitations

Due to the retrospective design of the study and the limited sample size, advanced survival analyses (e.g., Kaplan–Meier) were not performed, and survival results are presented using descriptive statistics. The results cannot be generalized due to the limited sample size and retrospective design; however, the study aims to contribute to the literature as real-life data from a single tertiary center.

5. Conclusion

This tertiary retrospective study observed that a large proportion of pediatric neuroblastoma cases were in the advanced and high-risk group, with higher mortality and recurrence rates. Our findings highlight the impact of patient profiles followed in a tertiary reference center on clinical outcomes. Although the results cannot be generalized due to the limited sample size and retrospective design, the study contributes to the literature in terms of real-life data reported from our country.

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– review and editing. B.B.: surgical data interpretation, formal analysis, writing – review, expert consultation. All authors read and approved the final version of the manuscript.

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