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Original Research Article

Benign Neural Tumors: A Clinicopathologic Analysis

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Abstract:

Background: Benign neural tumors, including schwannomas, neurofibromas, and meningiomas, are non-malignant growths originating from nerve tissues. Despite their benign nature, these tumors can cause significant morbidity due to their location and potential for recurrence, posing challenges in clinical management. Understanding the clinico-pathologic characteristics of these tumors is essential to optimize treatment strategies and improve patient outcomes.

Aim: This study aims to analyze the clinical presentations, histopathological features, and surgical outcomes of benign neural tumors, focusing on factors influencing recurrence and complications.

Methods: A descriptive observational study was conducted. A total of 57 participants diagnosed with benign neural tumors were included based on specific inclusion criteria. Data on demographics, tumor characteristics, clinical presentations, histopathological findings, and surgical outcomes were collected and analyzed using SPSS version 23.0. Statistical tests included descriptive analysis, Chi-square, and t-tests, with a p-value <0.05 considered significant.

Results: The study population consisted of 29 males and 28 females, with a mean age of 42.5 years. Schwannomas were the most common tumor type (56.1%), followed by neurofibromas (31.6%) and meningiomas (12.3%). Localized pain (66.7%) and neurological deficits (45.6%) were the predominant clinical symptoms. Complete resection was achieved in 86% of cases, with a recurrence rate of 5.3%, mainly seen in neurofibromas. The overall complication rate was 10.5%, including cerebrospinal fluid leakage and wound infections. A statistically significant correlation ($p=0.023$) was observed between neurofibromas and higher recurrence rates.

Conclusion: Benign neural tumors present diverse clinical challenges due to their location and histopathological variations. Surgical resection is effective, with low recurrence and complication rates, though neurofibromas exhibit a higher tendency for recurrence. Accurate diagnosis, tailored surgical planning, and vigilant postoperative monitoring are crucial for optimizing outcomes.

Recommendations: Future studies should focus on exploring adjunctive therapies, particularly for neurofibromas, to reduce recurrence rates. Additionally, incorporating genetic and molecular profiling could further enhance personalized treatment approaches for patients with benign neural tumors.

Keywords: *Benign neural tumors, schwannoma, neurofibroma, recurrence, clinico-pathologic analysis*

Introduction

Benign neural tumours are a broad category of neoplasms that can arise from the central and peripheral nervous systems' supporting tissues, peripheral nerves, or nerve sheath. These tumours, which include meningiomas, schwannomas, and neurofibromas, are slow-growing and non-cancerous, but they can nonetheless seriously impair health because they compress nearby structures [1]. Despite being benign, their location and possibility of recurrence make clinical care difficult. While the diagnosis and treatment of these tumours have greatly improved due to advancements in imaging and histological techniques, a thorough grasp of their clinicopathologic features is still necessary to maximise patient care [2]. Different tumour types have different incidence rates of benign neural tumours; schwannomas are the most frequent kind, making up about 60% of benign peripheral nerve sheath tumours [3]. A genetic condition called Neurofibromatosis Type 1 (NF1), which predisposes patients to numerous tumours along the nerve system, is commonly linked to neurofibromas [4]. Meningiomas can appear anywhere along the spinal cord, even though they usually originate in the cranial cavity, which adds to the variety of clinical presentations [5]. The location and size of the tumour determine the symptoms, which can include anything from incidental findings on imaging investigations to localised pain and neurological impairments. The mainstay of treatment is still surgical removal, which attempts to preserve neurological function while mitigating symptoms and averting future problems [6]. Even if these tumours are benign, there is a chance that they will return, especially if subtotal resection was performed or if the tumour has certain histopathologic characteristics [7]. Compared to other benign neural tumours, neurofibromas in particular have a greater recurrence rate, which could be explained by their diffuse development pattern and correlation with hereditary disorders such as NF1 [8]. The rates of complications and recurrence highlight the significance of careful surgical planning and ongoing patient monitoring for these patients. There has been a shift towards more individualised approaches in the treatment of brain tumours, as evidenced by recent research emphasising the relevance of molecular and genetic profiling in predicting tumour behaviour and customising management regimens [9]. This study aims to analyze the clinical presentations, histopathological features, and surgical outcomes of benign neural tumors, focusing on factors influencing recurrence and complications.

Methodology

Study Design: This study is a descriptive, observational analysis.

Study Setting: The study was conducted at the Department of Pathology, RDJMMCH, Turki, Muzaffarpur, between October 1, 2023, and March 31, 2024.

Participants: A total of 57 participants diagnosed with benign neural tumors during the study period were included in the research.

Inclusion Criteria:

- Patients of all ages and genders diagnosed with benign neural tumors confirmed by histopathological examination.
- Participants who provided informed consent to participate in the study.
- Cases with complete clinical and histopathologic data.

Exclusion Criteria:

- Patients with malignant neural tumors or tumors of uncertain malignant potential.

- Cases with incomplete clinical or histopathologic data.
- Patients who did not consent to participate in the study.

Bias: To minimize selection bias, all eligible patients diagnosed during the study period were included consecutively. Observer bias was reduced by having two independent pathologists review the histopathological slides.

Data Collection: Data were collected from patient records, including demographic information, clinical presentation, tumor location, imaging findings, surgical details, and histopathologic characteristics. The information was compiled using a standardized data collection form.

Procedure: Patients who met the inclusion criteria underwent a thorough clinical evaluation and surgical intervention as per standard medical protocols. Histopathological examination of the excised tumor tissue was performed, and findings were recorded. Additional immunohistochemical staining was used when required for diagnosis.

Statistical Analysis: Data was analysed using SPSS 23.0. Descriptive statistics aggregated demographic and clinical data. Continuous variables were shown as means and standard deviations, whereas categorical variables were frequencies and percentages. T-tests were used for categorical variables, chi-square or Fisher's exact for continuous variables. Statistical significance was achieved with p-values below 0.05.

Results

The study population included 29 males (50.9%) and 28 females (49.1%), with a mean age of 42.5 years (range: 15-70 years). The majority of the participants were in the age group of 30-50 years (n=32, 56.1%).

Table 1: Demographic Characteristics of Study Participants

Characteristic	Number (n=57)	Percentage (%)
Gender		
Male	29	50.9%
Female	28	49.1%
Age Group		
15-29 years	10	17.5%
30-50 years	32	56.1%
51-70 years	15	26.4%
Mean Age (years)	42.5 (±12.3)	

The majority of the benign neural tumors were schwannomas (n=32, 56.1%), followed by neurofibromas (n=18, 31.6%), and meningiomas (n=7, 12.3%). Tumor locations varied, with the most common sites being the spinal region (n=25, 43.9%) and the cranial region (n=18, 31.6%).

Table 2: Distribution of Tumor Types and Locations

Tumor Type	Number (n=57)	Percentage (%)	Common Location	Number (n=57)	Percentage (%)
Schwannoma	32	56.1%	Spinal	25	43.9%
Neurofibroma	18	31.6%	Cranial	18	31.6%
Meningioma	7	12.3%	Peripheral	14	24.5%

The most common clinical presentations were localized pain (n=38, 66.7%), neurological deficits such as weakness or sensory loss (n=26, 45.6%), and visible swelling or mass (n=14, 24.6%).

Table 3: Clinical Presentations of Participants

Clinical Presentation	Number (n=57)	Percentage (%)
Localized Pain	38	66.7%
Neurological Deficits	26	45.6%
Visible Swelling/Mass	14	24.6%
Incidental Finding	9	15.8%

Histopathological analysis confirmed the benign nature of all tumors. Schwannomas exhibited characteristic Verocay bodies in 28 cases (87.5%), while neurofibromas showed a mix of spindle cells with wavy nuclei in 16 cases (88.9%).

Table 4: Histopathological Features of Tumors

Tumor Type	Histopathological Feature	Number (n=57)	Percentage (%)
Schwannoma	Verocay Bodies	28/32	87.5%
Neurofibroma	Spindle Cells with Wavy Nuclei	16/18	88.9%
Meningioma	Whorled Patterns with Psammoma Bodies	5/7	71.4%

All patients underwent surgical excision of the tumors. Complete resection was achieved in 49 cases (86.0%), while subtotal resection occurred in 8 cases (14.0%) due to the tumor's proximity to vital structures. Recurrence was noted in 3 cases (5.3%) during the follow-up period, all of which were neurofibromas.

Table 5: Surgical Outcomes and Recurrence

Surgical Outcome	Number (n=57)	Percentage (%)
Complete Resection	49	86.0%
Subtotal Resection	8	14.0%
Recurrence Rate		
Recurrence	3	5.3%

Statistical Analysis

A comparison between tumor types and recurrence rates was performed using the Chi-square test, which showed a statistically significant correlation ($p=0.023$) between neurofibromas and higher recurrence rates. Additionally, age and gender did not show a significant correlation with tumor recurrence ($p>0.05$). The overall complication rate was 10.5% (n=6), with complications including cerebrospinal fluid leakage in 2 cases (3.5%), wound infection in 3 cases (5.3%), and transient neurological deficits in 1 case (1.7%).

Table 6: Postoperative Complications

Complication	Number (n=57)	Percentage (%)
Cerebrospinal Fluid Leakage	2	3.5%
Wound Infection	3	5.3%
Transient Neurological Deficit	1	1.7%

Discussion

The study involved 57 participants diagnosed with benign neural tumors, providing an in-depth look at their demographic characteristics, clinical presentations, histopathological findings, and surgical outcomes. The results indicated that the most common tumor type was schwannoma, accounting for 56.1% of cases, followed by neurofibromas and meningiomas.

The average age of participants was 42.5 years, with a balanced gender distribution, highlighting that these tumors affect a wide age range, predominantly middle-aged adults. The most frequent tumor locations were the spinal and cranial regions, with localized pain being the most common clinical symptom. This data suggests that benign neural tumors can present across various body sites and age groups, necessitating diverse diagnostic and therapeutic approaches.

Histopathological examination confirmed the benign nature of all tumors, with distinct features corresponding to each tumor type. Schwannomas typically showed Verocay bodies, neurofibromas displayed spindle cells with wavy nuclei, and meningiomas exhibited whorled patterns with psammoma bodies. These histopathologic characteristics are critical for differentiating between various benign neural tumors, aiding in precise diagnosis and appropriate management. The statistical analysis revealed a significant correlation between neurofibromas and higher recurrence rates, which underscores the need for careful long-term follow-up and potential adjuvant therapy in these cases.

Surgical excision proved to be an effective treatment, achieving complete resection in 86% of cases and a low recurrence rate of 5.3%. However, recurrence was more commonly observed in neurofibromas, suggesting a need for vigilant postoperative monitoring in these patients. Complications were minimal, with a 10.5% overall complication rate, including cerebrospinal fluid leakage, wound infections, and transient neurological deficits. These findings highlight the safety and efficacy of surgical intervention for benign neural tumors, with most patients achieving favorable outcomes.

Using machine learning approaches, this study aimed to distinguish between malignant and benign peripheral nerve sheath tumours (PNSTs). The study created a classifier model with 21 imaging and clinical variables by examining radiomics features taken from MRI images. In terms of tumour type discrimination, the model outperformed human specialists with a sensitivity of 0.676, specificity of 0.882, and an AUC of 0.845. According to the results indicate that the diagnostic accuracy of PNST evaluation can be markedly improved by incorporating machine learning into routine MRI imaging [10]. In order to distinguish between benign and malignant ovarian tumours, this study used deep neural networks (DNNs) to analyse ultrasound pictures. As evidenced by the DNN model's improved diagnosis accuracy over expert subjective assessment, AI-based technologies have the potential to improve diagnostic accuracy and decrease variability in clinical practice [11]. The rare benign neuroepithelial tumour known as PLNTY was examined in two patients in this study. The tumor's characteristic clinicopathological features, such as its oligodendroglioma-like appearance and particular genetic markers like the BRAF V600E mutation, were highlighted. Following surgery, both patients experienced good results, and follow-up revealed no recurrence. The research highlights the significance of histopathologic and genetic analysis in identifying and distinguishing PLNTY from other comparable lesions [12].

Conclusion

This study provides valuable insights into benign neural tumors, highlighting their clinical presentations, histopathological features, and surgical outcomes. Schwannomas, neurofibromas, and meningiomas were the most common, with surgical excision proving highly effective and associated with low complication and recurrence rates. However, neurofibromas showed a higher recurrence, suggesting a need for closer follow-up and potential additional therapies. Overall, early diagnosis and tailored surgical management are crucial for optimal patient outcomes, and further research should explore

strategies to minimize recurrence in neurofibromas.

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