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Original Article

Correlation Between Size of Vestibular Schwannoma and Severity of Hydrocephalus

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ABSTRACT

***Introduction**: Vestibular schwannomas (VS) are benign tumors that can lead to severe complications such as hydrocephalus, particularly as tumor size increases. This study aimed to investigate the correlation between the size of vestibular schwannomas and the severity of hydrocephalus, using the Evans index as a measure of ventricular enlargement. **Methods & Materials**: This retrospective study was conducted at a tertiary care hospital in Bangladesh, reviewing patient records from the past ten years. Fifty patients with confirmed vestibular schwannoma and hydrocephalus, diagnosed through magnetic resonance imaging (MRI), were included. Tumor size was measured in three dimensions, and the Evans index was used to assess hydrocephalus severity. Statistical analysis was performed using SPSS version 26 to evaluate the correlation between tumor size and hydrocephalus severity. **Result**: The study found a strong positive correlation between tumor size and the severity of hydrocephalus (r = 0.72, p < 0.001). Tumors measuring 0.5-1.5 cm had a mean Evans index of 0.32, while those greater than 4.5 cm had a mean Evans index of 0.45. No significant correlation was observed between age (r = 0.15, p = 0.31) or gender (r = -0.04, p = 0.78) and the Evans index, indicating that tumor size is the primary determinant of hydrocephalus severity in this population. **Conclusion**: The findings of this study underscore the critical role of tumor size in the development and severity of hydrocephalus in patients with vestibular schwannomas. These results suggest that treatment strategies should focus primarily on tumor characteristics to optimize patient outcomes.*

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***Keywords**: Vestibular Schwannoma, Hydrocephalus, Tumor Size, Evans Index, Correlation*

INTRODUCTION

Vestibular schwannomas (VS), also known as acoustic neuromas, are benign tumors that arise from the Schwann cells of the vestibular nerve. These tumors are commonly associated with unilateral sensorineural hearing loss and tinnitus. As vestibular schwannomas grow, they extend into the cerebellopontine angle (CPA), where they can compress the cerebellum, fourth ventricle, brainstem, and cranial nerves, particularly the seventh and fifth cranial nerves[1]. When large vestibular schwannomas compress the fourth ventricle, they may cause obstructive hydrocephalus (HCP), leading to symptoms such as papilledema, headaches, nausea, vomiting, and other signs of intracranial hypertension[2]. The incidence of hydrocephalus associated with vestibular schwannomas varies widely, ranging from 3.7% to 42%[3-5]. In patients with vestibular schwannomas, communicating hydrocephalus occurs more frequently (61%–87.2%) than obstructive hydrocephalus[2,6]. Several mechanisms have been proposed to explain communicating hydrocephalus, including tumor-induced protein leakage that obstructs cerebrospinal fluid (CSF) absorption at the arachnoid granulations, adhesions in the subarachnoid space that reduce intracranial compliance, meningeal adhesions due to minor tumor hemorrhages, and CSF malabsorption likely caused by tumor cells and elevated fibrinogen levels in the CSF[2,7]. After tumor removal and decompression of CSF pathways, symptoms of obstructive hydrocephalus are expected to resolve[8]. However, surgery in patients with elevated intracranial pressure (ICP) and hydrocephalus can be more challenging and may lead to higher complication rates, ranging from 5.1% to 36%, although direct evidence in the literature is limited[3,5,9]. Despite this, some surgeons prefer to manage hydrocephalus preoperatively with a ventriculoperitoneal (VP) shunt to stabilize the patient before tumor resection. Recent studies, however, suggest that complete removal of CPA tumors can resolve hydrocephalus without the need for a permanent shunt, making this the preferred treatment approach[5,10]. While direct surgery can spare many patients from permanent CSF diversion, postoperative monitoring is crucial because hydrocephalus may recur or persist, requiring additional interventions[11]. Categorizing hydrocephalus as obstructive or communicative is complex, as obstructive hydrocephalus may not improve after tumor removal due to factors such as intraoperative bleeding or protein-related blockage of arachnoid granulations[2,12]. Therefore, it is essential to develop personalized management plans to prevent the need for adjuvant therapies like VP shunting, lumbar drainage, or external ventricular drainage (EVD). Although surgeons typically avoid VP shunts due to the risks of infection, their invasive nature, and the need for valve adjustments, they remain necessary for a subset of patients with persistent hydrocephalus following tumor removal[5]. Previous studies have identified several factors associated with poor outcomes in patients with persistent hydrocephalus, including larger tumor size, advanced age, a larger cystic component, and more severe hydrocephalus[2,5,6]. Endoscopic third ventriculostomy (ETV) is a useful treatment option for managing hydrocephalus before and after tumor resection, though its use remains debated among surgeons[13-15].

METHODS & MATERIALS

This retrospective study was conducted at the Department of Neurosurgery, Combined Military Hospital, Dhaka, Bangladesh from June, 2013 to July, 2023. The study was designed as a retrospective analysis to investigate the correlation between the size of vestibular schwannomas and the severity of hydrocephalus in patients diagnosed with both conditions. Patient records from a tertiary care hospital over the past ten years were reviewed, and cases of vestibular schwannoma were identified. Inclusion criteria included patients who had undergone magnetic resonance imaging (MRI) to confirm the presence of vestibular schwannoma and hydrocephalus. Exclusion criteria were patients with other intracranial pathologies or those who had undergone prior cranial surgeries that might influence the development of hydrocephalus. The size of the vestibular schwannoma was measured in three dimensions (anteroposterior, mediolateral, and superoinferior) using MRI scans, and the maximum diameter was recorded for analysis. The severity of hydrocephalus was measured by measuring the Evans index, which is the ratio of the maximum width of the lateral ventricles' frontal horns to the maximum width of the skull's inner table at the same level on axial MRI slices. Patient demographics, tumor size, Evans index, and hydrocephalus-related clinical complaints were all recorded. SPSS version 26 was used to conduct statistical analysis to determine the relationship between vestibular schwannoma size and hydrocephalus severity.

RESULTS

The study included 50 patients diagnosed with vestibular schwannoma, with ages ranging from 20 to 69 years. The largest age group was 40-49 years, comprising 30% of the study population, followed by 24% in the 30-39 years range, and 20% in the 50-59 years range. A smaller proportion of patients were aged 20-29 years (10%) and 60-69 years (16%). The majority of the patients were male (56%), while females constituted 44% of the cohort. Regarding tumor size, most tumors were between 1.6-2.5 cm in diameter (30%), followed by 24% of tumors measuring 2.6-3.5 cm, and 20% measuring 0.5-1.5 cm. Larger tumors were less common, with 16% of tumors measuring 3.6-4.5 cm and only 10% exceeding 4.5 cm in diameter. The tumors were more frequently located on the right side (60%) compared to the left side (40%). This distribution highlights that middle-aged adults are more commonly affected by vestibular schwannoma, with a slightly higher prevalence in males. Tumor sizes varied, but the most common sizes were between 1.6 and 3.5 cm, with a predominance of right-sided tumors (**Table I**).

Table – I: Patient Demographics and Tumor Characteristics (*n*=50)

Variable	Frequency	Percentage
Age Range (Years)		
20-29	5	10
30-39	12	24
40-49	15	30
50-59	10	20
60-69	8	16
Gender		
Male	28	56
Female	22	44
Tumor Size (cm)		
0.5-1.5	10	20
1.6-2.5	15	30
2.6-3.5	12	24
3.6-4.5	8	16
>4.5	5	10
Location of Tumor		
Right	30	60
Left	20	40

The severity of hydrocephalus, as measured by the Evans index, showed a clear correlation with tumor size among the 50 patients. Tumors measuring 0.5-1.5 cm in diameter were associated with a mean Evans index of 0.32, with a range of 0.28 to 0.35. As the tumor size increased, the mean Evans index also increased, indicating more severe hydrocephalus. For tumors sized 1.6-2.5 cm, the mean Evans index was 0.34, with a range of 0.29 to 0.38. Tumors measuring 2.6-3.5 cm had a mean Evans index of 0.37, ranging from 0.32 to 0.41. Larger tumors, particularly those in the 3.6-4.5 cm range, were associated with a mean Evans index of 0.41, with a range between 0.35 and 0.45. The most severe hydrocephalus was observed in patients with tumors greater than 4.5 cm, where the mean Evans index reached 0.45, with a range of 0.40 to 0.50 (**Table II**).

Table – II: Severity of Hydrocephalus Based on Evans Index (*n*=50)

Tumor Size (cm)	Frequency (*n*=50)	Percentage	Mean Evans Index	Range of Evans Index
0.5-1.5	10	20	0.32	0.28 - 0.35
1.6-2.5	15	30	0.34	0.29 - 0.38
2.6-3.5	12	24	0.37	0.32 - 0.41
3.6-4.5	8	16	0.41	0.35 - 0.45
>4.5	5	10	0.45	0.40 - 0.50

The analysis revealed a strong positive correlation between tumor size and hydrocephalus severity, as indicated by the Evans index, with a correlation coefficient (r) of 0.72 and a statistically significant p-value of less than 0.001. This suggests that larger vestibular schwannomas are strongly associated with more severe hydrocephalus. In contrast, the correlation between age and hydrocephalus severity was weak and not statistically significant (r=0.15, *p*=0.31), indicating that age does not have a significant impact on the severity of hydrocephalus in this cohort. Similarly, there was no significant correlation between gender and hydrocephalus severity (r= -0.04, *p*=0.78), suggesting that gender does not influence the extent of hydrocephalus in patients with vestibular schwannoma (**Table III**).

Table – III: Correlation Between Tumor Size and Hydrocephalus Severity

Variable	Correlation Coefficient (r)	*p*-value
Tumor Size (cm) vs. Evans Index	0.72	<0.001
Age vs. Evans Index	0.15	0.31
Gender vs. Evans Index	-0.04	0.78

DISCUSSION

The current study investigated the correlation between the size of vestibular schwannomas (VS) and the severity of hydrocephalus, measured using the Evans index, in a cohort of patients from a tertiary care hospital in Bangladesh. Our findings reveal a strong positive correlation between tumor size and the severity of hydrocephalus (r=0.72, *p*<0.001), suggesting that larger vestibular schwannomas are significantly associated with more severe hydrocephalus. This correlation is consistent with previous studies that have reported similar associations between tumor size and hydrocephalus severity. For example, ***Rogg et al.*** found a significant correlation between tumor volume and hydrocephalus severity, particularly in cases of non-communicating hydrocephalus, reinforcing the notion that larger tumors are more likely to induce severe hydrocephalus[4]. Similarly, ***Gerganov et al.*** identified tumor size as a key predictor for the necessity of cerebrospinal fluid (CSF) diversion post-surgery, further supporting the critical role of tumor size in hydrocephalus pathogenesis[5]. Interestingly, our study did not find significant correlations between age or gender and the Evans index, indicating that these factors may not play a major role in determining hydrocephalus severity in patients with vestibular schwannomas. This observation aligns with findings from other studies, such as those by ***Dzefi-Tettey et al.*** and ***Hamidu et al.,*** which also reported no significant correlation between gender and the Evans index, suggesting that tumor size is likely the primary determinant of hydrocephalus severity rather than demographic factors[16,17]. Additionally, ***Brix et al.*** and ***Brutto et al.*** reported that while the Evans index may increase with age, this change does not appear to significantly impact the severity of hydrocephalus when adjusted for other factors, further supporting the idea that tumor size is the dominant factor[18,19]. The distribution of tumor sizes and their association with hydrocephalus severity in our study reflects trends observed in other regions, indicating that our findings are consistent with global patterns. Studies by Harun et al. and Ostler et al. have documented similar tumor size distributions and demographic characteristics in different populations, with a predominance of right-sided tumors and a higher incidence in males[20,21]. These studies emphasize that while tumor size is a universal determinant of hydrocephalus severity, the demographic variations observed may reflect population-specific factors that do not significantly alter the overall correlation between tumor size and hydrocephalus severity. In clinical practice, the management of hydrocephalus associated with vestibular schwannomas remains challenging, especially in regions with limited healthcare resources. The findings from our study underscore the importance of accurate tumor size assessment using advanced imaging techniques to predict hydrocephalus severity and guide treatment planning. This is in line with the conclusions drawn by ***Tanaka et al.***, who highlighted the necessity of detailed neuroimaging in managing such cases, particularly in older patients who may present with more complex clinical profiles[6]. Moreover, the absence of significant correlations between demographic factors and hydrocephalus severity further suggests that treatment strategies should primarily focus on tumor characteristics rather than patient demographics, a conclusion also supported by ***Ambarki et al.***, who emphasized the limitations of relying solely on linear indices like the Evans index for comprehensive patient assessment[22]. In summary, our study reinforces the critical role of tumor size in determining the severity of hydrocephalus in patients with vestibular schwannomas, while also highlighting the limited impact of demographic factors such as age and gender. These findings have important implications for the clinical management of these patients, particularly in guiding surgical decisions and predicting postoperative outcomes. Future research should continue to explore the complex interplay between tumor characteristics and hydrocephalus severity, with an emphasis on improving diagnostic and treatment strategies in diverse patient populations.

Limitations of the Study:

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

In this study, we found a significant positive correlation between the size of vestibular schwannomas and the severity of hydrocephalus, as measured by the Evans index. This correlation highlights the importance of early detection and precise measurement of tumor size in managing patients with vestibular schwannomas to prevent or mitigate the effects of hydrocephalus. While demographic factors such as age and gender did not significantly influence hydrocephalus severity, tumor size emerged as the primary determinant. These findings underscore the need for targeted treatment strategies that prioritize tumor characteristics over patient demographics, potentially improving clinical outcomes in affected individuals. Future research should continue to explore the underlying mechanisms of this correlation and refine management approaches to optimize patient care.

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Conflict of Interest

The authors declare no conflict of interest.

Ethical approval: The study was approved by the Institutional Ethics Committee

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