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Diagnostic Value of Apparent Diffusion Coefficient (ADC) and Tumor Size Based on Magnetic Resonance Imaging (MRI) to Determine Malignant Posterior Fossa Brain Tumors in Children

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ABSTRACT

Posterior fossa tumors in children are a diagnostic challenge that requires early and appropriate treatment. This study aims to evaluate the diagnostic value of Apparent Diffusion Coefficient (ADC) and tumor size using Magnetic Resonance Imaging (MRI) in distinguishing malignant and benign tumors in the posterior fossa of children. The research method employs a retrospective approach, analyzing medical records of pediatric patients who underwent MRI and histopathology examinations at Ngoerah Hospital Denpasar. The results showed that an ADC value of ≤834.6 mm²/s had a sensitivity of 91.3%, a specificity of 70.3%, and an accuracy of 78.0%. Meanwhile, tumor size >13.2 cm³ showed a sensitivity of 91.3%, specificity of 51.8%, and accuracy of 68.0%. The combination of these two parameters resulted in a sensitivity of 87.5%, specificity of 96.1%, and accuracy of 92.0%, indicating a significant improvement in diagnostic accuracy. Thus, the simultaneous use of ADC values and tumor size is an effective approach for detecting malignant posterior fossa tumors in children, supporting more accurate diagnosis and appropriate clinical treatment.

KEYWORDS ADC, Tumor size, MRI, tumor fossa posterior, malignant tumors of children, diagnosis non-invasif

INTRODUCTION

Brain tumors in children are a serious health problem that requires early diagnosis and proper treatment. One type of tumor that often occurs in children is *posterior fossa brain tumor*, which includes medulloblastoma, ependymoma, glioblastoma multiforme (GBM), atypical rhabdoid/teratoid tumor (ATRT), and brainstem glioma. Until recently, it has often been difficult to diagnose early malignant *posterior fossa brain tumors* in pediatric patients. This may be due to a variety of factors, such as the tumor's difficult-to-reach location, small tumor size, and limited detection capabilities (BAUDOU et al., 2024; Liu et al., 2023; McFaline-Figueroa & Lee, 2018; Mian Awais et al., 2022; Pietsch, 2023).

An accurate diagnosis and differentiation between malignant tumors in pediatric patients is essential for proper treatment planning and prognosis. *Magnetic Resonance Imaging (MRI)* is the primary imaging modality for *posterior fossa tumor* evaluation. In recent years, advanced MRI techniques, such as *diffusion-weighted imaging (DWI)* and *apparent diffusion coefficient (ADC)*, have shown

promise in differentiating benign and malignant tumors (Brandão & Young Poussaint, 2017).

ADC is a quantitative measure of the diffusion of water molecules in tissues. Malignant tumors usually show lower *ADC* values than benign tumors due to their higher cellularity, thus limiting water diffusion. In addition, tumor size has been suggested as a potential indicator of malignancy, with larger tumors tending to be malignant (Zitouni et al., 2017).

The urgent need for this research stems from the critical gap in non-invasive diagnostic approaches for pediatric *posterior fossa tumors*. Currently, definitive diagnosis requires invasive histopathological examination through biopsy or surgical resection, which carries significant risks in children, particularly when tumors are located in eloquent brain regions. The *posterior fossa* contains vital structures such as the brainstem and cerebellum, making surgical interventions technically challenging and potentially life-threatening. Early and accurate diagnosis is crucial because delayed treatment of malignant tumors can lead to rapid disease progression, increased intracranial pressure, and neurological deterioration. Furthermore, the similar clinical presentations of benign and malignant *posterior fossa tumors* make differential diagnosis extremely challenging based on clinical symptoms alone, necessitating reliable non-invasive diagnostic tools.

A retrospective study in the United States reported that *ADC* values showed significant differences among tumor types: pilocytic astrocytoma versus medulloblastoma, pilocytic astrocytoma versus ependymoma, pilocytic astrocytoma versus ATRT, medulloblastoma versus ependymoma, and ependymoma versus ATRT. Analysis of the Receiver Operating Characteristic (ROC) curve showed a sensitivity of 94.9% and a specificity of 93.3% to distinguish medulloblastoma from ependymoma (Gonçalves et al., 2022). However, several research gaps exist in the current literature: First, most studies focus on individual parameters (either *ADC* values or tumor size) rather than their combined diagnostic potential. Second, optimal cut-off values for *ADC* measurements vary significantly across studies, ranging from 800–1000 × 10^{-6} mm^2/s, indicating the need for population-specific thresholds. Third, limited research has been conducted in Southeast Asian pediatric populations, where genetic and environmental factors may influence tumor characteristics differently.

In addition to *ADC* value, the size of the tumor on *MRI* is also related to tumor malignancy. One study showed a 25% higher frequency of malignancy in lesions of 20 mm or larger on *MRI* compared to smaller lesions at 12% (Liberman et al., 2006). However, this study was conducted in adult breast lesions, and its applicability to pediatric brain tumors remains unclear.

Currently, the use of *ADC* values to detect different types of tumors has been proven significant in various previous studies because it shows high sensitivity and specificity in distinguishing tumors such as pilocytic astrocytoma, medulloblastoma, ependymoma, and ATRT. However, the novelty of this research lies in: (1) a combined approach—this is the first study to systematically evaluate the diagnostic performance of combined *ADC* values and tumor size specifically in an Indonesian pediatric population with *posterior fossa tumors*; (2) population-specific cut-off values—establishing optimal threshold values for both parameters in a Southeast Asian pediatric cohort, which may differ from Western populations due to genetic and environmental factors; (3) comprehensive diagnostic metrics—

providing complete diagnostic performance evaluation including sensitivity, specificity, positive and negative predictive values, and likelihood ratios for both individual and combined parameters; and (4) clinical applicability—developing a practical diagnostic algorithm that can be readily implemented in resource-limited settings.

The use of *MRI* to determine the diagnostic value of *ADC* and tumor size to distinguish malignant *posterior fossa tumors* in children is still limited. Based on this background, this study was conducted to develop non-invasive diagnostic methods such as *MRI* in pediatric radiology for determining malignant *posterior fossa brain tumors* to enable more appropriate clinical treatment and reduce the need for invasive procedures such as biopsies.

The primary objective of this research is to develop non-invasive diagnostic methods using *MRI* in pediatric radiology to determine malignant *posterior fossa brain tumors* more rapidly and accurately, ultimately reducing the need for invasive procedures such as biopsies. The specific objectives include: (1) determining the sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), Likelihood Ratio Positive (LRP), and Likelihood Ratio Negative (LRN) of *ADC* diagnostic values in identifying malignant *posterior fossa tumors* in pediatric patients; (2) determining the sensitivity, specificity, PPV, NPV, LRP, and LRN of tumor size for the same purpose; (3) comparing the diagnostic performance of *ADC* values and tumor size; and (4) determining the diagnostic performance of the combination of *ADC* values and tumor size.

The clinical benefits of this research include enhanced diagnostic accuracy leading to more timely and appropriate treatment decisions, reduced need for invasive diagnostic procedures in pediatric patients, improved risk stratification for surgical planning, a cost-effective diagnostic approach implementable in various healthcare settings, and establishment of evidence-based guidelines for non-invasive diagnosis of pediatric *posterior fossa tumors* in the Indonesian population.

RESEARCH METHOD

This research is within the scope of Radiology, Child Health Sciences and Neurosurgery. This study is a diagnostic test conducted retrospectively to determine the differences in sensitivity, specificity, PPV, NPV, LRP, LRN from the ADC Value diagnostic value and tumor size in determining malignant posterior fossa tumors in pediatric patients. This study used data based on medical records and MRI examinations in the form of ADC Value and tumor size and with gold standard in histopathological examination in pediatric patients with posterior fossa tumors at Ngoerah Hospital Denpasar. The research design can be described as follows:

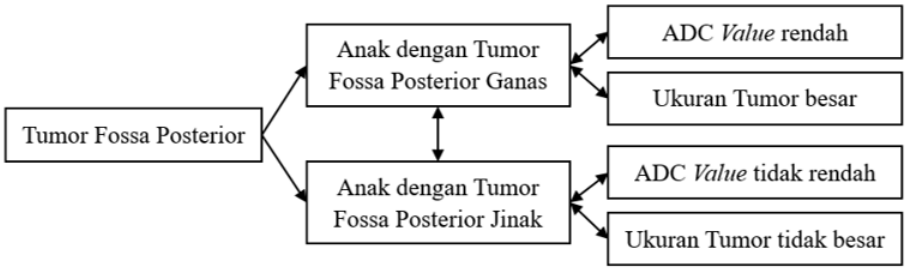

Figure 1. Research Design

The research was conducted at the Medical Record Installation and Radiology Installation at Ngoerah Hospital Denpasar starting in January 2020 until the number of samples was met. The target population of this study is all medical records of pediatric patients with posterior fossa brain tumors who underwent MRI examination. The sample of this study is part of the affordable population that meets the inclusion and exclusion criteria so that eligible subjects are obtained.

The research sample was obtained by a nonrandom sampling method of consecutive sampling from the medical records of pediatric patients with posterior fossa brain tumors that were examined by MRI and have been histopathologically proven at Ngoerah Denpasr Hospital starting in January 2020 until the number of patients was met.

The source of research data is secondary data from medical records and MRI examination results of pediatric patients with posterior fossa tumors obtained from PACS at the Radiology Installation of Ngoerah Hospital Denpasar.

RESULTS AND DISCUSSION

Subject Characteristics

Table 1 shows the distribution of the characteristics of the study subjects based on age and gender. In terms of age, the majority of respondents were in the age range of 1–11 years, with a percentage of 56%, while the rest, namely 44%, were aged 12–18 years. The median age of the study subjects was 11 years, with an Interquartile Range (IQR) of 11 years. In terms of gender, the composition of respondents is divided almost evenly, with 56% male and 44% female. Thus, the research subjects were dominated by the young age group (1–11 years) and men. The full results are presented in table 1.

Table 1 Distribution of Characteristics of Research Subjects

Characteristic	Result
Median age (years) (IQR)	11 (11)
1-11 n (%)	28 (56,0)
12-18 n (%)	22 (44,0)
Gender	
Male n (%)	28 (56,0)
Female n (%)	22 (44,0)

Reciper Operating Characteristic (ROC) Analysis and Determination of Cutting Points

In this study, a Receiver Operating Characteristic (ROC) analysis was carried out to determine the optimal cut-off point of two variables, namely the Apparent Diffusion Coefficient (ADC) value and tumor size. ROC analysis is used to evaluate the diagnostic ability of these two variables to distinguish between certain conditions, for example between benign and malignant tumors.

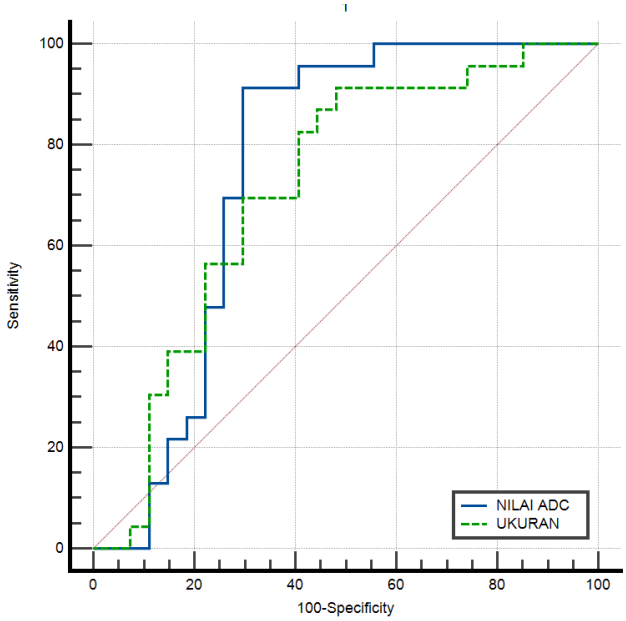

Figure 2. Difference in ROC ADC value curve and Tumor size

Information:
AUC: 0,74 vs 0,71; 95% CI: 0,60 - 0,86 vs 0,57 - 0,83; p value: 0,001

Based on Figure 2, the ROC curve for each variable can be seen, namely ADC value and tumor size. The ROC curve shows the sensitivity and specificity of the various cut values for each variable. The closer the ROC curve is to the upper left corner of the graph, the better the diagnostic accuracy of the variable. The results of the analysis showed the difference in Area (AUC) value between two test variables, namely ADC Value and Tumor Size. For the ADC Value variable, AUC has a value of 0.74 with a Standard Error of 0.07 and a 95% confidence interval ranging from 0.60 to 0.86. The p-value obtained is 0.001, which indicates high statistical significance. On the other hand, for the Tumor Size variable, the AUC has a value of 0.71 with a Standard Error of 0.07 and a 95% confidence interval between 0.57 and 0.83, with a p-value of also 0.001, which is also significant. Furthermore, to prove that there is a significant difference between the ADC Value diagnostic value and the Tumor Size in determining the condition being tested, an independent t test was performed. The test results showed that the p-value obtained was <0.01, which showed that the AUC ADC Value was statistically significantly different from the Tumor Size. Thus, both ADC Value and Tumor Size show good diagnostic ability, but ADC Value has a slightly better ability to distinguish the tested condition based on the AUC value.

ADC value diagnostic value in determining malignant posterior fossa tumors in pediatric patients

Table 2 ADC value diagnostic value in determining malignant posterior fossa tumors in pediatric patients

ADC Value (mm2/s)	Histopathology		Sn	Sp	PPV	NPV	LR+	LR-	Aku
	Malignant f (%)	Benign f (%)							
≤834,6	20 (71,4)	8 (28,6)	91,3%	70,3%	71,4%	86,4%	3,08	0,12	78,0%
>834,6	3 (13,6)	19 (86,4)							
Total	23 (46,0)	27 (54,0)							

Based on table 2, at an ADC value of ≤834.6, as many as 71.4% of patients had malignant tumors based on histopathology, while the other 28.6% had benign tumors. The sensitivity of this method is very high, at 91.3%, indicating the ability to detect most cases of malignant tumors. Its specificity was 70.3%, which indicates the ability to identify patients with benign tumors as non-malignant tumors. A Positive Predictive Value (PPV) of 71.4% shows that if the ADC value is ≤834.6, the probability of the patient having a malignant tumor is 71.4%. In contrast, a Negative Predictive Value (NPV) of 86.4% shows that if the ADC value is >834.6, the probability of the patient not having a malignant tumor is 86.4%.

In addition, a Positive Likelihood Ratio (LR+) of 3.08 indicates that an ADC value of ≤834.6 increases the likelihood of malignant tumors by 3.08 times compared to before the test was performed. A Negative Likelihood Ratio (LR-) of 0.12 indicates that an ADC result of >834.6 significantly reduces the likelihood of malignant tumors. With an overall accuracy of 78.0%, the ADC value showed a good level of reliability in distinguishing malignant tumors from benign tumors in pediatric posterior fossa.

Diagnostic value of tumor size in determining malignant posterior fossa tumors in pediatric patients

Table 3. Diagnostic value of tumor size in determining malignant posterior fossa tumors in pediatric patients

Tumor size (cm^3)	Histopathology		Sn	Sp	PPV	NPV	LR +	LR -	Aku
	Malignant f (%)	Benign f (%)							
>13.2	21 (60,0)	14 (40,0)	91,3 %	51,8 %	60,0 %	86,7 %	1,90	0,17	68,0 %
≤13.2	2 (13,3)	13 (86,7)							
Total	23 (46,0)	27 (54,0)							

Based on table 3, for a tumor size of >13.2 cm^3, as many as 60.0% of patients had malignant tumors based on histopathology, while 40.0% had benign tumors. The sensitivity of this method is very high, i.e. 91.3%, which indicates the ability to detect most cases of malignant tumors. However, the specificity was lower, at 51.8%, which suggests that the ability to identify patients with benign tumours as non-malignant tumours is quite limited.

A Positive Predictive Value (PPV) of 60.0% showed that if the tumor size was >13.2 cm^3, the probability of the patient having a malignant tumor was 60.0%.

In contrast, the Negative Predictive Value (NPV) of 86.7% shows that if the tumor size is ≤13.2 cm³, the probability of the patient not having a malignant tumor is 86.7%. In addition, a Positive Likelihood Ratio (LR+) of 1.90 indicates that a tumor size of >13.2 cm³ increases the likelihood of malignant tumors by up to 1.90 times. Meanwhile, a Negative Likelihood Ratio (LR-) of 0.17 showed that a tumor size of ≤13.2 cm³ lowered the likelihood of malignant tumors to 0.17 times. With an overall accuracy of 68.0%, tumor size showed a moderate degree of reliability in distinguishing malignant tumors from benign tumors in pediatric patients' posterior fossa.

Combination of ADC diagnostic values and tumor size in determining malignant posterior fossa tumors in pediatric patients

Table 4 ADC value diagnostic value with tumor size in determining malignant posterior fossa tumors in pediatric patients

ADC Value by tumor size	Histopathology		Sn	Sp	PPV	NPV	LR+	LR-	Aku
	Malignant f (%)	Benign f (%)							
Positive	21 (95,5)	1 (4,5)							
Negative	3 (10,7)	25 (89,3)	87,5%	96,1%	95,5%	89,3%	22,7	0,13	92,0%
Total	24 (48,0)	26 (52,0)							

Table 4 shows the diagnostic results of a combination of ADC value and tumor size in determining the type of malignant posterior fossa tumor in pediatric patients. Sensitivity (87.5%) indicates that this test is effective in detecting malignant tumors, while specificity (96.1%) indicates high accuracy in identifying benign tumors. A Positive Predictive Value (PPV) of 95.5% indicates that a positive test result almost certainly leads to malignant tumors, while a Negative Predictive Value (NPV) of 89.3% indicates the reliability of the test in identifying patients without malignant tumors. A Positive Likelihood Ratio (LR+) of 22.7 reinforces a positive outcome as a strong indicator of the presence of malignant tumors, and a Negative Likelihood Ratio (LR-) of 0.13 indicates a low probability of error in a negative outcome. The 92.0% accuracy confirms that this combination has excellent diagnostic performance, effective in detecting malignant tumors with minimal error rate.

Characteristics of Posterior Fossa Tumor Patients

The study involved 50 subjects with posterior fossa tumors, consisting of 28 males (56%) and 22 females (44%). The composition of these sexes is almost even, with little dominance in males. These findings are consistent with the results of previous studies that mention that posterior fossa tumors tend to be more common in boys, a finding supported by research by Brandão and Young Poussaint (2017). Their research revealed that biological or hormonal factors, such as differences in the development of the central nervous system in boys and girls, could be one of the causes of the higher prevalence in boys. In addition, environmental and genetic factors are also believed to play a role in the difference in tumor incidence in the two sexes.

Most of the subjects of the study were in the age range of 1–11 years, which accounted for 56% of the total sample, while the rest, 44%, were aged 12–18 years. The median age of the subjects was 11 years with an Interquartile Range (IQR) of 11 years, indicating that the majority of patients with posterior fossa tumors were in childhood to early adolescence. This finding is in line with the findings of Bray and Sappington (2022), which show that posterior fossa tumors are most commonly found in children compared to adults. This type of tumor is known to have special characteristics in age development, where at a younger age, tumors are more often found in the posterior fossa due to the role of the craniopharyngeal and cerebellum that develops rapidly during childhood.

On the other hand, tumor size and the patient's gender are important factors in the prognosis of posterior fossa tumors. Although data regarding tumor size were not elaborated in this study, previous research by Prasad et al. (2017) showed that more severe clinical symptoms, such as vomiting, headache, and balance disturbances, were more commonly found in patients with large tumors in the posterior fossa area. This suggests that tumor size, which is often associated with the rate of invasion and neurological complications, can provide an idea of the severity of the patient's condition. In children, large posterior fossa tumors often cause increased intracranial pressure, which affects the central nervous system, especially the brainstem and cerebellum, which play an important role in motor function and balance.

Age factors also play an important role in determining the type and severity of posterior fossa tumors. In younger children, posterior fossa tumors such as medulloblastoma and pilocytic astrocytoma are more common, while at older ages, glioblastoma and other malignant tumors may be more prevalent. This is in accordance with the findings of Birkholz and Davis (2020), who emphasized that the posterior fossa has a complex structure that is highly susceptible to tumor compression. The presence of a tumor in this part can affect the nerve functions that regulate the body's balance, vision, and coordination, and potentially cause serious neurological symptoms such as ataxia, diplopia, and increased intracranial pressure.

In addition, the results of this study also underline the importance of anatomical factors in the development of posterior fossa tumors. The posterior fossa is a complex location, containing vital structures such as the cerebellum, brain stem, and medulla oblongata. Compression in this area can cause significant neurological dysfunction. Research by Formentin et al. (2024) also suggests that the large size of the tumor in the posterior fossa can lead to a significant increase in intracranial pressure, which risks interfering with the brainstem function that controls the body's vital activity. In this context, the patient's tumor size, sex, and age should be thoroughly evaluated to plan the optimal diagnostic and therapeutic approach.

Thus this study provides a clear picture of the characteristics of subjects with posterior fossa tumors, including age and sex distribution. These findings reinforce the understanding that biological, hormonal, and age factors play an important role in the development of posterior fossa tumors in children. Additionally, these findings underscore the importance of thorough evaluation of clinical factors such as age, sex, and neurological symptoms to determine the appropriate diagnosis and treatment strategy for patients with posterior fossa tumors.

ADC Value Diagnostic Value in Determining Malignant Posterior Fossa Tumors in Pediatric Patients

The ADC (Apparent Diffusion Coefficient) value is one of the important parameters that can help distinguish malignant tumors and benign tumors in children's posterior fossa. Based on this study, the ADC value of ≤834.6 mm²/s has a very high sensitivity, which is 91.3%, indicating a good ability to detect most cases of malignant tumors. In this category, as many as 71.4% of patients with an ADC value of ≤834.6 were confirmed to have malignant tumors based on histopathology, while another 28.6% had benign tumors. However, its specificity of 70.3% suggests that this method is not entirely optimal in identifying patients with benign tumours as non-malignant tumours.

A Positive Predictive Value (PPV) of 71.4% shows that if the ADC value is ≤834.6, the probability of the patient having a malignant tumor is 71.4%. In contrast, a negative predictive value (NPV) of 86.4% indicates that if the ADC value is >834.6, the probability of the patient not having malignant tumors is 86.4%. In addition, a Positive Likelihood Ratio (LR+) value of 3.08 showed that an ADC value of ≤834.6 increased the likelihood of malignant tumors by 3.08 times compared to before the examination was carried out. On the other hand, a Negative Likelihood Ratio (LR-) value of 0.12 indicates that an ADC result of >834.6 significantly lowers the likelihood of malignant tumors. With an overall accuracy of 78.0%, this method is quite reliable in distinguishing malignant tumors from benign tumors in children's posterior fossa.

This discovery supports previous studies that highlight the superiority of ADC value in differentiating posterior fossa tumor types. Jaremko et al. (2010) showed that ADC imaging is one of the most useful methods in differentiating posterior fossa tumors in children. They found that malignant tumors, such as medulloblastoma, had lower ADC values than benign tumors, such as pylocytic astrocytoma. The optimal threshold they used to differentiate between medulloblastoma and sulocytic astrocytoma was a minimum ADC value of 800 × 10^6 mm²/s, which is close to the results of this study. Another study by Rumboldt et al. (2006) also found that an average ADC value of 900 × 10^6 mm²/s was effective for differentiating these tumors, although their approach used the average ADC value instead of the minimum value.

Pathologically, the ADC value reflects the diffusivity of water in the tumor tissue, which depends on the cellular density and structure of the tumor tissue. Malignant tumors, such as medulloblastomas, usually have a high cellular density, which inhibits water diffusion and results in low ADC values. In contrast, benign tumors, such as pylocytic astrocytoma, have a lower cellular density, thus allowing for higher water diffusion and resulting in greater ADC values (Mascalchi et al., 2005; Zitouni et al., 2017). This relationship explains why ADC values are effective at differentiating the degree of tumor malignancy.

Overall, the ADC value of ≤834.6 mm²/s provides high sensitivity in detecting malignant tumors, but has limitations in specificity. Nonetheless, ADC imaging remains an important method in the diagnosis of posterior fossa tumors, especially when combined with other diagnostic approaches such as histopathology and MRI imaging. The use of ADC values as biomarkers can help doctors in planning more appropriate treatment strategies and provide more accurate predictions of the patient's prognosis.

Diagnostic Value of Tumor Size in Determining Malignant Posterior Fossa Tumors in Pediatric Patients

Tumor size is one of the important parameters in assessing the level of malignancy of posterior fossa tumors in children. Based on the data, tumors with a size of more than 13.2 cm^3 have a very high sensitivity, which is 91.3%, indicating the ability of this method to detect most cases of malignant tumors. In this category, as many as 60.0% of patients with a tumor size of >13.2 cm^3 had malignant tumors based on histopathological results, while the other 40.0% had benign tumors. However, the specificity of this method is relatively low, at 51.8%, which means that the ability to identify patients with benign tumors as non-malignant tumors is still limited.

In addition, a Positive Predictive Value (PPV) of 60.0% indicates that if the tumor size is >13.2 cm^3, the patient's chance of having a malignant tumor is 60.0%. In contrast, a negative predictive value (NPV) of 86.7% showed that if the tumor size was ≤13.2 cm^3, the patient's chance of not having a malignant tumor was 86.7%. A Positive Likelihood Ratio (LR+) value of 1.90 indicates that a tumor size of >13.2 cm^3 increases the likelihood of malignant tumors almost twice compared to before the test was performed. On the other hand, a Negative Likelihood Ratio (LR-) value of 0.17 showed that a tumor size result of ≤13.2 cm^3 significantly reduced the likelihood of malignant tumors. The overall accuracy of this method is 68.0%, indicating a moderate level of reliability in distinguishing malignant tumors from benign tumors.

Tumor size is one of the indicators that is closely related to the biological nature and aggressiveness of the tumor. Larger tumors tend to have more invasive characteristics, rapid growth rates, and higher spreadability. In this study, tumor sizes of >13.2 cm^3 were often associated with malignant tumors, supporting previous studies that confirmed that large tumors were more likely to be malignant. Research by Liberman et al. (2006) showed that tumors with a size of ≥20 mm had a malignancy rate of 25%, compared to smaller tumors that only had a malignancy rate of 12%. This suggests a strong association between tumor size and malignancy risk.

The size of the tumor on MRI imaging is often measured using the parameters of longest diameter, shortest diameter, and thickness of the tumor, which are then calculated into volumes in cm^3 or mm^3. This volume calculation provides a more detailed picture of the dimensions of the tumor, especially in comparing the risk of malignancy between small and large sizes. Malignant tumors tend to have a larger volume due to rapid cellular growth and infiltration into surrounding tissues, while benign tumors typically have more defined boundaries and slow growth.

Although the size of the tumor provides significant information, it is important to consider that not all large tumors are malignant, and some small tumors may exhibit aggressive malignant traits. This suggests that tumor size should be used as part of a more holistic diagnostic approach, along with other parameters such as ADC values, histopathology, and clinical signs.

The results of this study showed that the tumor size of >13.2 cm^3 had a high sensitivity in detecting malignant tumors, although the specificity was lower. The relationship between tumor size and malignancy is consistent with the existing literature, which suggests that large tumors are more often malignant. However, to

get an accurate diagnosis, the size of the tumor needs to be used in conjunction with other diagnostic parameters such as ADC values and histopathological examinations. This multidisciplinary approach is important to ensure appropriate treatment strategies and improve the prognosis of patients with posterior fossa tumors.

Difference in Ability of ADC diagnostic value with tumor size in determining malignant posterior fossa tumors in pediatric patients

In this study, a Receiver Operating Characteristic (ROC) analysis was carried out to evaluate and compare the diagnostic ability between two variables, namely ADC (Apparent Diffusion Coefficient) value and tumor size, in distinguishing malignant and benign tumors in pediatric patients with posterior fossa tumors. The resulting ROC curve shows that these two variables have good potential in differentiating the two types of tumors, with AUC values of 0.74 for ADC value and 0.71 for tumor size, respectively. Although both show fairly good AUC values, ADC values are slightly superior in terms of their diagnostic capabilities, given their higher AUC values.

A larger AUC ADC value indicates that this variable has a better ability to distinguish between malignant and benign tumors when compared to tumor size. These findings are supported by previous studies showing that ADC values, which reflect the diffusivity of water in tumor tissue, have an important role in differentiating malignant tumors from benign tumors. Malignant tumors, such as medulloblastoma, typically have a high cellular density that inhibits water diffusion and results in low ADC values, while benign tumors, such as pylocytic astrocytoma, have lower cellular density and allow for higher water diffusion (Baliyan et al., 2016; Mascalchi et al., 2005). Thus, ADC value provides more direct information related to the cellular and structural characteristics of the tumor that can be used to differentiate the type of tumor.

Meanwhile, the size of the tumor also shows high sensitivity in detecting malignant tumors. However, the specificity is lower, which suggests that the size of the tumor may not always be able to accurately identify benign tumors. Previous research has shown that larger tumors tend to be malignant in nature due to their faster growth rate and ability to spread to surrounding tissues (Prasad et al., 2017). Larger tumor sizes are often associated with malignant tumors, but it is important to note that not all large tumors are malignant, and some small tumors can also have aggressive malignant properties. Therefore, although tumor size is an important indicator in assessing tumor malignancy, size alone is not enough to provide an accurate diagnosis without considering other factors such as ADC values or histopathological results.

The comparison between ADC values and tumor size also showed important differences in terms of predictability. The ADC value of $\leq$834.6 mm^2/s indicates high sensitivity for detecting malignant tumors, but the specificity is lower compared to tumor size. Lower specificity suggests that ADC value, while effective in detecting malignant tumors, has limitations in distinguishing between benign and malignant tumors, particularly in cases where benign tumors have low ADC values similar to malignant tumors. In contrast, a tumor size with a cut-off point of >13.2 cm^3 has high sensitivity but also has low specificity. This means that while the size of a large tumor is very likely to indicate malignancy, there is also the possibility

that the large tumor is benign, which indicates the importance of using additional parameters to improve the accuracy of diagnosis.

In terms of prediction, the ADC value showed a higher positive predictive value (PPV), which was 71.4%, which suggests that if the ADC value is ≤834.6, the probability of malignant tumors in patients is 71.4%. In contrast, tumor size showed a lower PPV, which was 60.0%. This shows that ADC value is more reliable in predicting tumor malignancy. The Positive Likelihood Ratio (LR+) value for the ADC value of 3.08 showed that a low ADC value increased the likelihood of malignant tumors by more than three times, while the LR+ for a tumor size of 1.90 showed an increase in the likelihood of malignant tumors by almost double. Nonetheless, the LR- for ADC value was 0.12, which suggests that a higher ADC yield significantly lowers the likelihood of malignant tumors. Meanwhile, LR- for a tumor size of 0.17 indicates that a smaller tumor size also reduces the likelihood of malignancy by a significant degree.

Although both parameters, both ADC value and tumor size, make an important contribution in the diagnosis of posterior fossa tumors, the use of ADC value is superior in terms of specificity and overall diagnostic value. This finding is in line with the research of Jaremko et al. (2010), which showed that ADC value is a very useful parameter in distinguishing the type of posterior fossa tumor in children. Thus, although tumor size can provide important information regarding the growth rate and invasiveness of tumors, ADC value offers an advantage in distinguishing malignant and benign tumors more precisely based on the microscopic and structural characteristics of the tumor tissue.

Overall, the combination of ADC value and tumor size, along with histopathological examination, will provide more accurate and comprehensive diagnostic results. Although ADC values are slightly superior in terms of diagnostic capabilities, they should be used simultaneously in a multidisciplinary approach to improve accuracy in determining the type of posterior fossa tumor in pediatric patients. This approach will help doctors in planning more effective treatment strategies and provide more accurate predictions of the patient's prognosis.

Combination of ADC diagnostic values and tumor size in determining malignant posterior fossa tumors in pediatric patients

The combination of ADC (Apparent Diffusion Coefficient) value and tumor size provides excellent diagnostic results in detecting malignant tumors in the posterior fossa in pediatric patients. The results of this study showed a very high sensitivity, which was 87.5%, which indicates the test's ability to detect most cases of malignant tumors. High sensitivity is essential in a diagnostic context, as it can help ensure that almost all cases of malignant tumors are detected at an early stage, which can increase the chances of more effective treatment (Zitouni et al., 2017). Although there is a possibility of false negatives, the high sensitivity makes the combination of ADC value and tumor size a very useful tool in the process of early detection of posterior fossa tumors in children.

The recorded specificity of 96.1% shows that this test is very effective in identifying benign tumors with a very low error rate. In other words, this test is able to well distinguish benign tumors from malignant tumors, which is an important aspect in differentiating between the two types of tumors. High specificity means that it is likely that tumors detected with negative test results are completely non-

malignant, which indicates the reliability of the test in providing a precise diagnosis. In line with previous research by Baliyan et al. (2016), which showed that imaging with ADC parameters provides reliable results in distinguishing benign and malignant tumors based on tumor tissue structure and cellularity, these results further confirm that ADC value is an effective diagnostic tool.

In addition, a Positive Predictive Value (PPV) value of 95.5% indicates that a positive result on this test almost certainly leads to the diagnosis of malignant tumors. This high PPV gives doctors confidence that a positive result on this test has a very high probability of actually indicating the presence of malignant tumors, which is very important in clinical decision-making and determining the right treatment. On the other hand, the Negative Predictive Value (NPV) of 89.3% indicates that this test is also reliable in identifying patients who do not have malignant tumors. A high NPV indicates that a negative result provides a higher certainty that the patient does not have a malignant tumor, and thus, the next step in the diagnostic process can be more focused on the truly at-risk patient.

With a Positive Likelihood Ratio (LR+) value of 22.7, the combination of ADC and tumor size strengthened the positive outcome as a strong indicator of the presence of malignant tumors. This very high LR+ indicates that a positive result from this test significantly increases the likelihood of malignant tumors, almost 23 times higher compared to the initial probability before the test was performed. This is in line with the findings in a study by Koh and Padhani (2006), which confirmed that ADC values can be an effective differentiator in distinguishing malignant tumors from benign tumors by significantly increasing the probability of malignant tumor diagnosis. In contrast, a Negative Likelihood Ratio (LR-) value of 0.13 indicates that a negative result greatly lowers the likelihood of malignancy, giving more confidence that patients with a negative test result are most likely not to have a malignant tumor.

An overall accuracy of 92.0% confirms that the combination of ADC value and tumor size has excellent diagnostic performance, with minimal error rate. This high accuracy indicates that the combination of these two parameters can be relied upon to provide a precise diagnosis for both malignant and benign tumors, and can be used with high confidence in clinical practice. Previous research by Jaremko et al. (2010) and Rumboldt et al. (2006) also showed that the combination of imaging parameters and tumor size resulted in increased accuracy in the diagnosis of posterior fossa tumors, which supports the finding that the use of the two together provides better diagnostic outcomes.

The combination of ADC value and tumor size makes a major contribution to a more precise diagnosis in differentiating malignant and benign tumors in children's posterior fossa. With high sensitivity and specificity, as well as PPV and NPV that support accuracy, this test provides excellent diagnostic results with little chance of error. With a very high LR+ and a low LR- level, this combination further strengthens the ability to detect malignant tumors and accurately assess the absence of malignant tumors. Therefore, the use of a combination of ADC value and tumor size is highly recommended in clinical practice as a reliable and effective diagnostic tool in the management of posterior fossa tumors in children. This approach can provide more accurate information, help plan more appropriate treatment, and improve long-term patient outcomes

CONCLUSION

Based on the results, the apparent diffusion coefficient (ADC) value is an effective tool for detecting malignant posterior fossa tumors in pediatric patients, demonstrating higher sensitivity (91.3%), specificity (70.3%), and overall accuracy (78.0%) compared to tumor size measurements, which showed lower specificity (51.8%) and accuracy (68.0%). Importantly, combining ADC values with tumor size significantly improves diagnostic performance, achieving excellent specificity (96.1%) and accuracy (92.0%), making it the superior approach. Clinically, a two-step diagnostic algorithm is recommended: initial screening with ADC cut-off ≤834.6 mm^2/s for sensitive detection, followed by combined assessment with tumor size >13.2 cm^3 for precise diagnosis. For future research, longitudinal studies with larger cohorts are necessary to validate and standardize these cut-offs across different MRI machines and field strengths. Additionally, exploring other diffusion parameters like fractional anisotropy and mean diffusivity may enhance diagnostic accuracy further. Standardizing MRI protocols and implementing radiologist training in diffusion-weighted imaging interpretation should be prioritized to facilitate consistent clinical application.

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