

# Diagnostic Accuracy of Apparent Diffusion Coefficient value in Detection of Intracranial Malignant Meningioma Taking Histopathology as Gold Standard

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## ABSTRACT

**Background:** Meningiomas represent the most prevalent type of primary non-gliar intracranial tumors located outside the brain's neural tissue. They typically develop on the brain's surface and are seldom found within the brain ventricles. The measurement of ADC values is a dependable and non-invasive method for distinguishing between benign and malignant meningiomas. **Objective:** To evaluate the diagnostic accuracy of apparent diffusion coefficient value in detection of intracranial malignant meningioma taking histopathology as gold standard. **Study Design:** Cross-sectional study. **Settings:** The present study was conducted at the Radiology Department of Liaquat University of Medical and Health Sciences. **Duration:** Study was done during a period of six months from Jan 2021 to July 2021. **Methods:** Patients suspected for intracranial meningiomas who have undergone imaging studies and subsequently received histopathological confirmation were included. ADC maps were analyzed by experienced radiologists who were blinded to the histopathological results. ADC values were recorded and used for subsequent analysis. Histopathological reports of patients who underwent surgical resection or biopsy were obtained from the pathology department. The presence or absence of malignant meningioma was determined based on histopathological analysis, which served as the gold standard for diagnosis. All the information was collected via study proforma and analysis was done by using SPSS version 20. **Results:** A total of 40 individuals who were suspected of having intracranial malignant meningioma were studied; their mean age of the patients was  $42.25 \pm 9.98$  years. Females were in majority 25(62.2%) and males were 15(37.5%). Apparent diffusion coefficient value showed the sensitivity 82%, specificity 82%, PPV 77%, NPV 86% and accuracy 82% in the diagnosis of intracranial malignant meningioma by taking histopathology as gold standard. **Conclusion:** ADC values have proven to be a dependable and non-invasive technique for effectively distinguishing between benign and malignant meningiomas.

**Keywords:** Intracranial malignant meningioma, Diagnosis, ADC, Sensitivity, Specificity.

## INTRODUCTION

Meningioma is the prevailing primary neoplasm affecting the central nervous system (CNS).<sup>1</sup> In accordance with the 2016 classification by the World Health Organization (WHO) for tumors in the central nervous system, meningiomas are categorized into three grades based on their invasive characteristics and histopathological features.<sup>2,3</sup> Approximately 80% of

meningiomas are benign grade I tumors known as low-grade meningiomas,<sup>4</sup> while the remaining cases consist of grade II atypical meningiomas and grade III malignant meningiomas, classified as high-grade meningiomas.<sup>2</sup> Approximately 10% of meningiomas are classified as malignant, leading to increased morbidity and mortality rates.<sup>5</sup> The elderly population is predominantly affected, with the highest occurrence typically observed between the ages of 60 and 70 years.<sup>6,7</sup> Although males tend to

exhibit a higher occurrence of atypical and malignant meningiomas.<sup>6,7</sup> The management approach for meningiomas is strongly influenced by the tumor grade. Surgical removal is considered suitable for low-grade meningiomas, while adjuvant radiotherapy is advised for high-grade meningiomas.<sup>2,8</sup> Therefore, accurately predicting the tumor grade of meningiomas before surgery is of utmost importance in clinical settings.<sup>2</sup> Histological grading is an evaluative technique employed to anticipate the biological behavior of tumors, including meningiomas, and is considered the most significant factor affecting progression-free survival.<sup>6,9</sup> Apparent diffusion coefficient (ADC) is an emerging and dependable non-invasive method that is widely utilized for the preoperative evaluation and treatment strategizing of various brain tumor types.<sup>10</sup>

In the case of malignant meningiomas, ADC values tend to be lower, indicating restricted diffusion and potentially reflecting the increased cellularity and cellular packing within the tumor. These lower ADC values are associated with more aggressive tumor behavior and poorer treatment outcomes. Current study has been conducted to evaluate the diagnostic accuracy of apparent diffusion coefficient value in detection of intracranial malignant meningioma taking histopathology as gold standard.

**METHODS**

The present study was conducted as a cross-sectional investigation at the Radiology Department of Liaquat University of Medical and Health Sciences. Study was done during a period of six months from Jan 2021 to July 2021. All the patients with suspected intracranial meningiomas who have undergone imaging studies and subsequently received histopathological confirmation were included and no specific age and gender limitations unless specified by the study protocol. Patients who have not undergone diffusion-weighted imaging (DWI) with ADC mapping as part of their diagnostic workup, patients with incomplete or insufficient ADC data or inadequate image quality for reliable interpretation, individuals who have received treatment (e.g., surgery, radiation therapy, chemotherapy) prior to imaging and histopathological confirmation which may affect the accuracy of ADC values and individuals with a known diagnosis of benign meningioma or other intracranial pathologies unrelated to malignant meningioma were excluded. After thoroughly explaining the research protocol, verbal informed consent was obtained from each participant. This process involved providing a detailed explanation of the study objectives, procedures, confidentiality measures, and voluntary participation. Relevant clinical data, including patient demographics and medical history, were collected from medical records. ADC maps were analyzed by experienced radiologists who were blinded to the histopathological results. The

ADC values were measured within regions of interest (ROIs) placed over the suspected meningioma areas. ADC values were recorded and used for subsequent analysis. Histopathological reports of patients who underwent surgical resection or biopsy were obtained from the pathology department. The presence or absence of malignant meningioma was determined based on histopathological analysis, which served as the gold standard for diagnosis. All the information was collected via study proforma and analysis was done by using SPSS version 20.

**RESULTS**

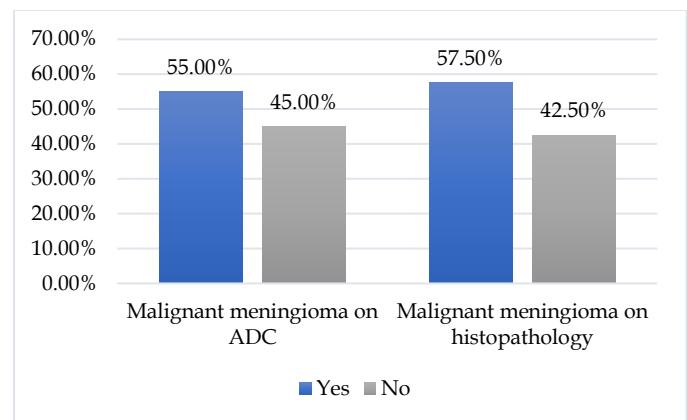
In the current study, a total of 40 individuals who were suspected of having intracranial malignant meningioma were studied. Mean age of the patients was 42.25±9.98 years and mean duration of symptoms was 14.77±5.90 weeks. Females were in majority 25(62.2%) and males were 15(37.5%). Table 1

**Table 1: Descriptive statistics of age, gender and duration of symptoms (n=40)**

	Variables	Statistics
<b>Age</b>	Mean ± SD	42.25 ± 9.98 years
<b>Duration of symptoms</b>	Mean ± SD	14.77 ± 5.90 weeks
<b>Gender</b>	Males	15 (37.5%)
	Females	25 (62.2%)

In this study intracranial malignant meningioma was observed in 55.0% cases by ADC and it was diagnosed in 57.50% of the cases by histopathology. Figure 1

**Figure 1: Frequency of malignant meningioma on ADC and histopathology (n=40)**



In this study apparent diffusion coefficient value showed the sensitivity 82%, specificity 82%, PPV 77%, NPV 86% and accuracy 82% in the diagnosis of intracranial malignant meningioma by taking histopathology as gold standard. Table 2

**Table 2: Diagnostic accuracy of ADC value by taking histopathology as gold standard (n=40)**

ADC value	Histopathology		Total
	Positive	Negative	
Positive	14 TP	04 FP	18
Negative	03 FN	19 TN	22
Total	17	23	40

Sensitivity: 82%, Specificity: 82%, PPV: 77%, NPV: 86%, Accuracy: 82%

## DISCUSSION

Intracranial malignant meningioma refers to a type of brain tumor that originates from the meninges, the protective membranes surrounding the brain and spinal cord. Meningiomas are typically benign tumors, but in rare cases, they can become malignant or aggressive. The non-invasive diagnosis of intracranial malignant meningioma typically involves the use of various imaging techniques to assess the characteristics of the tumor. This study has been done to evaluate the diagnostic accuracy of apparent diffusion coefficient value in detection of intracranial malignant meningioma and a total of 40 individuals who were suspected of having intracranial malignant meningioma were studied. Mean age of the patients was  $42.25 \pm 9.98$  years, females were in majority 25(62.2%) and males were 15(37.5%). In the comparison of this study Mahmood A *et al*<sup>11</sup> reported that the higher proportion of female patients with benign meningiomas was not found in the non-benign category. In the case of atypical and malignant meningiomas, the ratio of males to females was 1:0.9, while for benign meningiomas, it was 1:2.3. On the other hand, Rohringer M *et al*<sup>12</sup> reported that in malignant meningiomas, the ratio of males to females was 1:1. Yang L *et al*<sup>13</sup> conducted a clinicopathological study on intracranial angiomatous meningioma and they reported that the out of 23 cases 13 were males and 10 were females, overall mean age was 54.2 years and duration average was 14.9 months. The controversy surrounding gender predominance in intracranial malignant meningioma arises from conflicting findings reported in different studies. While some studies have suggested a higher prevalence of these tumors in females, others have reported equal or even higher incidences in males. Variations in the study populations, including sample sizes, geographical locations, and ethnic backgrounds, can influence the observed gender ratios. These differences may result in conflicting findings among studies conducted in different regions or populations.

In this study, the apparent diffusion coefficient (ADC) value demonstrated a sensitivity of 82%, specificity of 82%, positive predictive value (PPV) of 77%, negative

predictive value (NPV) of 86%, and overall accuracy of 82% for diagnosing intracranial malignant meningioma when compared to histopathology, which was considered the gold standard. These findings were supported by other studies.<sup>14-16</sup> ADC values reflect the degree of water diffusion within tissues and can provide crucial insights into tumor characteristics. In the case of malignant meningiomas, lower ADC values are often observed, indicating restricted diffusion and suggesting a more aggressive tumor behavior. By quantifying the ADC, clinicians can gain important information for treatment planning and prognosis assessment in patients with malignant meningiomas.

## CONCLUSION

ADC values have proven to be a dependable and non-invasive technique for effectively distinguishing between benign and malignant meningiomas. By analyzing the ADC values obtained through diffusion-weighted imaging (DWI), clinicians can accurately differentiate between the two tumor types. ADC measurements into clinical practice can enhance the management and decision-making process for patients with intracranial malignant meningioma.

## LIMITATIONS

Due to limited sample size and other inherent limitations of the study, the results cannot be considered conclusive or definitive.

## SUGGESTIONS / RECOMMENDATIONS

Therefore, further comprehensive studies are needed to enhance and validate the clinical utility of ADC in the context of differentiating between benign and malignant meningiomas.

## CONFLICT OF INTEREST / DISCLOSURE

None.

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