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Application of Radiomics Based on CE-T1WI and DWI in the Diagnosis of Submucosal Uterine Fibroids and Endometrial Carcinoma

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Abstract

Objective: To explore the application value of radiomics based on CE-T1WI and DWI in the diagnosis of submucosal uterine fibroids and endometrial carcinoma. **Methods:** A total of 33 patients with pathologically confirmed endometrial carcinoma and 30 patients with submucosal uterine fibroids were selected. Their CE-T1WI and DWI imaging data were collected, and radiomics features such as arterial phase enhancement, venous phase enhancement, diffusion restriction, ADC values, and time-signal curve types were analyzed. **Results:** In the arterial phase, the number of cases with enhancement lower than the myometrium was significantly higher in the endometrial carcinoma group than in the submucosal fibroid group (χ^2 = 22.4509, P = 0.0000), while the number of cases with slightly higher enhancement showed a statistically significant difference (χ^2 = 13.1146, P = 0.0003). In the venous phase, the number of cases with enhancement higher than the myometrium was lower in the endometrial carcinoma group than in the submucosal fibroid group (χ^2 = 5.1583, P = 0.0231). Regarding diffusion restriction, the number of cases with restricted diffusion was significantly higher in the endometrial carcinoma group (χ^2 = 37.6794, P = 0.0000). Among cases with ADC values recorded, the ADC value in the endometrial carcinoma group (0.71 ± 0.22) was significantly lower than that in the submucosal fibroid group (1.34 ± 0.28) (χ^2 = 7.1828, P = 0.0000). No significant difference was observed in the time-signal curve types between the two groups (χ^2 = 0.6969, P = 0.4107). **Conclusion:** Radiomics features based on CE-T1WI and DWI have significant value in the diagnosis of submucosal uterine fibroids and endometrial carcinoma, providing a reliable basis for clinical diagnosis.

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Keywords

Submucosal Uterine Fibroids, Endometrial Carcinoma, Magnetic Resonance Imaging (MRI), Diffusion-Weighted Imaging (DWI), Contrast-Enhanced T1-Weighted Imaging (CE-T1WI)

1. Introduction

Endometrial carcinoma is one of the three major malignant tumors of the female reproductive system, primarily originating from the endometrial epithelium [1]. It commonly occurs in postmenopausal women, with a higher incidence in the age group of 50 to 64 years. Clinically, patients often present with symptoms such as vaginal bleeding, abnormal vaginal discharge, and lower abdominal pain. In contrast, submucosal uterine fibroids are uterine fibroids that protrude into the uterine cavity, typically manifesting as abnormal uterine bleeding, dysmenorrhea, menorrhagia, prolonged menstruation, and potential complications such as anemia and infertility. Therefore, accurate differentiation between endometrial carcinoma and submucosal uterine fibroids is crucial before clinical treatment [2].

Magnetic resonance imaging (MRI) has been widely recognized as a primary imaging modality for endometrial lesions, particularly in diagnosis and staging [3]. Studies have shown that MRI features, including lesion morphology, signal intensity, functional imaging, and enhancement characteristics, provide essential clinical evidence for distinguishing benign from malignant tumors. However, there is some overlap in imaging features between endometrial carcinoma and submucosal uterine fibroids, making their differentiation challenging [4]-[6]. Additionally, the treatment strategies for these two conditions differ significantly: endometrial carcinoma typically requires total hysterectomy and bilateral salpingo-oophorectomy (with optional pelvic and para-aortic lymphadenectomy), while submucosal fibroids can be managed with hysteroscopic myomectomy [7] [8]. Therefore, it is particularly crucial to explore the application of radiomics of CE-T1WI and DWI in the differential diagnosis of endometrial carcinoma and submucous myoma of the uterus. The three-dimensional imaging diagrams of endometrial carcinoma and submucous myoma of the uterus are shown in **Figures 1(A)-(D)**.

In recent years, with the continuous development of MRI technology, diagnostic methods based on morphology, functional features, and molecular characteristics have been widely applied. Radiomics increasingly employs techniques such as feature redundancy reduction, dimensionality reduction, and preprocessing, combined with machine learning classification methods, to objectively extract high-throughput features from images. These methods help establish robust and clinically relevant prognostic models, providing quantitative and objective support for tumor detection and treatment decision-making [9] [10]. This study aims to utilize CE-T1WI and DWI radiomics models to effectively differentiate be-

tween endometrial carcinoma and submucosal uterine fibroids.

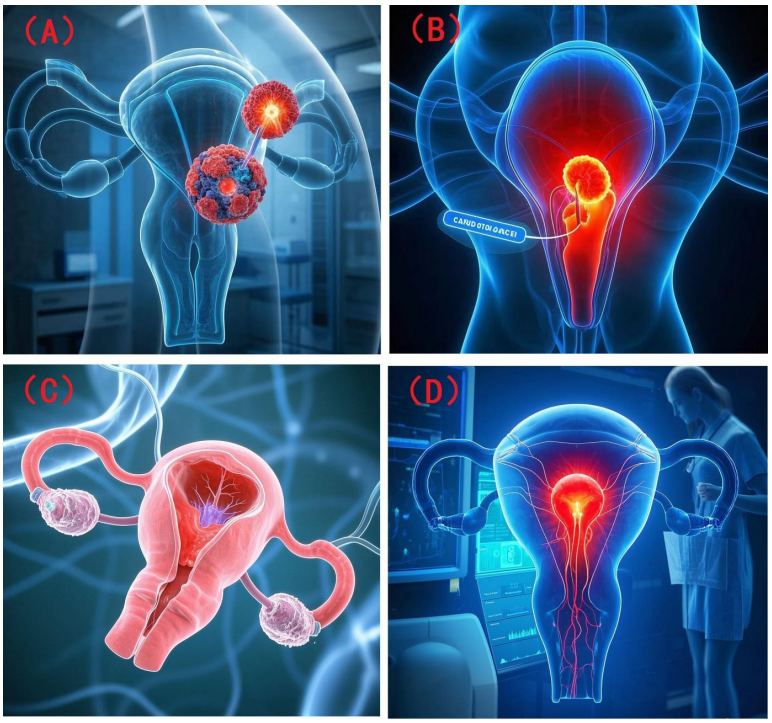

Figure 1. (A)-(B): Three-dimensional imaging diagrams of endometrial carcinoma; (C)-(D): Three-dimensional imaging diagrams of submucous myoma of the uterus.

2. Materials and Methods

2.1. General Materials

This study retrospectively collected data from 63 patients diagnosed with endometrial carcinoma or submucosal uterine fibroids by postoperative pathology at our hospital from January 2020 to March 2025. All patients had symptoms such as vaginal discharge or irregular bleeding lasting from 6 months to 1 year. The endometrial carcinoma group included 33 patients aged 38 to 73 years (mean age: 55.2 ± 8.4 years), while the submucosal fibroid group included 30 patients aged 31 to 71 years (mean age: 46.5 ± 9.3 years). All patients met the inclusion criteria and provided informed consent before the study. The research protocol was approved by the hospital ethics committee.

2.2. Examination Methods

All patients underwent MRI examination. The United Imaging uMR560 1.5T MRI scanner was used, and a pelvic MRI scan was performed with an abdominal coil. During the scan, the patients maintained free breathing. After injecting the contrast agent Gd-DTPA at a dose of 0.1 mmol/kg, enhanced scanning was carried out. The specific parameter settings for the MRI scan were as follows: 1) Sagittal T2-weighted imaging (T2WI): the inversion time (TR) was 3300 ms, the echo time (TE) was 91 ms, the field of view was 230 mm × 230 mm, the slice thickness was

5 mm, and the slice interval was 1 mm. 2) Axial T2-weighted imaging (T2WI): TR was 2500 ms, TE was 87 ms, the field of view was 250 mm × 250 mm, the slice thickness was 5 mm, and the slice interval was 1 mm. 3) Axial diffusion weighted imaging (DWI): the b value was set to 0 and 1000 s/mm^2, TR was 5000 ms, TE was 7 ms, the field of view was 300 mm × 300 mm, the slice thickness was 5 mm, and the slice interval was 1 mm. 4) Axial VIBE-T1-weighted imaging (enhanced): TR was 2500 ms, TE was 87 ms, the field of view was 250 mm × 250 mm, the slice thickness was 5 mm, and the slice interval was 1 mm.

2.3. Statistical Analysis

Data were analyzed using SPSS 27.0 software. Continuous variables were expressed as mean (standard deviation), and group comparisons were performed using independent samples t-tests. A P-value < 0.05 was considered statistically significant. All statistical analyses were two-sided.

3. Results

In the arterial phase of CE-T1WI, 24 out of 33 endometrial carcinoma cases showed enhancement lower than the myometrium, 7 cases showed slightly lower enhancement, 1 case showed slightly higher enhancement, and 1 case showed higher enhancement. In contrast, among 30 submucosal fibroid cases, 4 showed lower enhancement, 8 showed slightly lower enhancement, 1 showed equal enhancement, 12 showed slightly higher enhancement, and 5 showed higher enhancement. Statistical analysis revealed significant differences between the two groups in terms of lower enhancement (χ^2 = 22.4509, P = 0.0000) and slightly higher enhancement (χ^2 = 13.1146, P = 0.0003).

In the venous phase, 25 endometrial carcinoma cases showed lower enhancement, 6 showed slightly lower enhancement, 2 showed equal enhancement, and none showed slightly higher or higher enhancement. Among submucosal fibroid cases, 16 showed lower enhancement, 3 showed slightly lower enhancement, 4 showed equal enhancement, 6 showed slightly higher enhancement, and 1 showed higher enhancement. The difference in higher enhancement between the two groups was statistically significant (χ^2 = 5.1583, P = 0.0231). (Table 1, Table 2)

Regarding DWI findings, 25 out of 33 endometrial carcinoma cases showed restricted diffusion, 8 showed partial restriction, and none showed unrestricted diffusion. Among 30 submucosal fibroid cases, none showed restricted diffusion, 9 showed partial restriction, and 21 showed unrestricted diffusion. The difference in diffusion restriction between the two groups was highly significant (χ^2 = 37.6794, P = 0.0000). Among cases with ADC values recorded, the mean ADC value in the endometrial carcinoma group (0.71 ± 0.22) was significantly lower than that in the submucosal fibroid group (1.34 ± 0.28) (χ^2 = 7.1828, P = 0.0000). No significant difference was observed in time-signal curve types between the two groups (χ^2 = 0.6969, P = 0.4107). The imaging features and time-intensity curves (absolute signal intensity) of endometrial carcinoma and submucous myoma of the uterus

are shown in Figure 2 and Figure 3, and the specific data are shown in Tables 3-5.

Table 1. Comparison of the enhancement degree in the arterial phase between the two groups.

Group	Number of cases	Lower than myometrium	Slightly lower than myometrium	Equal to myometrium	Slightly higher than myometrium	Higher than myometrium
Endometrial carcinoma	33	24	7	0	1	1
Submucous myoma of the uterus	30	4	8	1	12	5
χ^2 value	—	22.4509	0.2577	—	13.1146	1.9932
P value	—	0.0000	0.6117	—	0.0003	0.1580

Note: For the comparison of the number of cases with enhancement higher than and lower than the myometrium between the two groups, $\chi^2 = 20.0629$, P = 0.0000.

Table 2. Comparison of the enhancement degree in the venous phase between the two groups.

Group	Number of cases	Lower than myometrium	Slightly lower than myometrium	Equal to myometrium	Slightly higher than myometrium	Higher than myometrium
Endometrial carcinoma	33	25	6	2	0	0
Submucous myoma of the uterus	30	16	3	4	6	1
χ^2 value	—	3.4770	0.3208	0.3052	5.1583	—
P value	—	0.0622	0.5711	0.5806	0.0231	—

Note: The comparison of cases with enhancement higher and lower than the myometrium between the two groups yielded $\chi^2 = 7.1795$, P = 0.0074.

Table 3. Comparison of whether there is restriction between the two groups.

Group	Number of cases	Diffusion restriction	Partial diffusion restriction	No restriction
Endometrial carcinoma	33	25	8	0
Submucous myoma of the uterus	30	0	9	21
χ^2 value	—	37.6794	0.2644	36.1362
P value	—	0.0000	0.6071	0.0000

Note: The overall comparison of diffusion restriction between the two groups yielded $\chi^2 = 34.6500$, P = 0.0000.

Table 4. Comparison of ADC values with records due to restriction between the two groups.

Group	Number of cases	ADC value
Endometrial carcinoma	33	0.71 ± 0.22
Submucous myoma of the uterus	9	1.34 ± 0.28
χ^2 value	—	7.1828
P value	—	0.0000

Note: Generally, when the ADC value is <1, the likelihood of malignancy is higher, and when the ADC value is >1, the likelihood of a benign condition is higher. In this study, only 9 cases in the submucosal uterine fibroid group showed partial diffusion restriction, and all had ADC values greater than 1.

Table 5. Comparison of the type of time-signal curve.

Group	Number of cases	Rapid rise and slow decline type	Rapid rise and plateau type
Endometrial carcinoma	33	7	26
Submucous myoma of the uterus	30	4	26
χ^2 value	—	0.6969	
P value	—	0.4107	

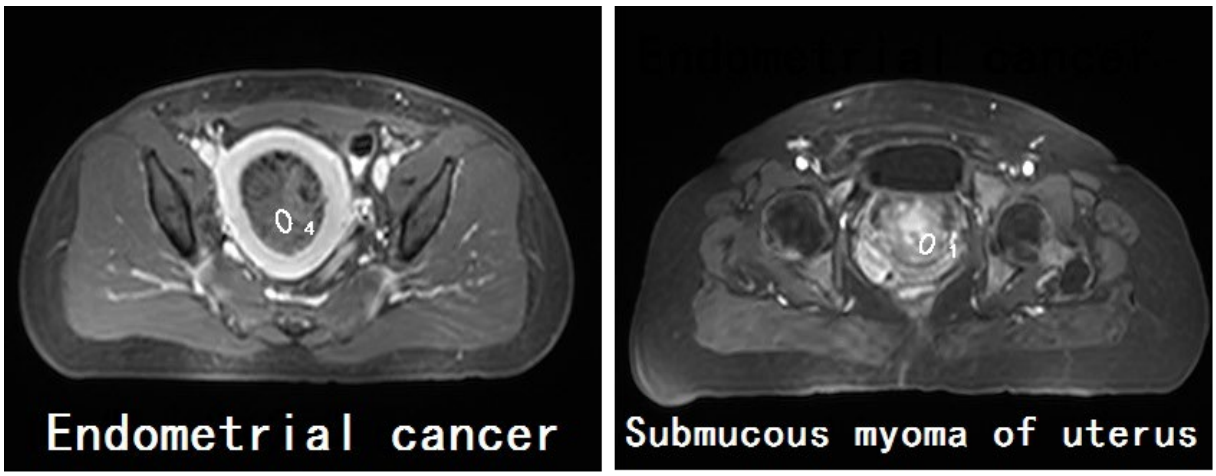

Figure 2. Comparison of the imaging features between endometrial carcinoma and submucous myoma of the uterus.

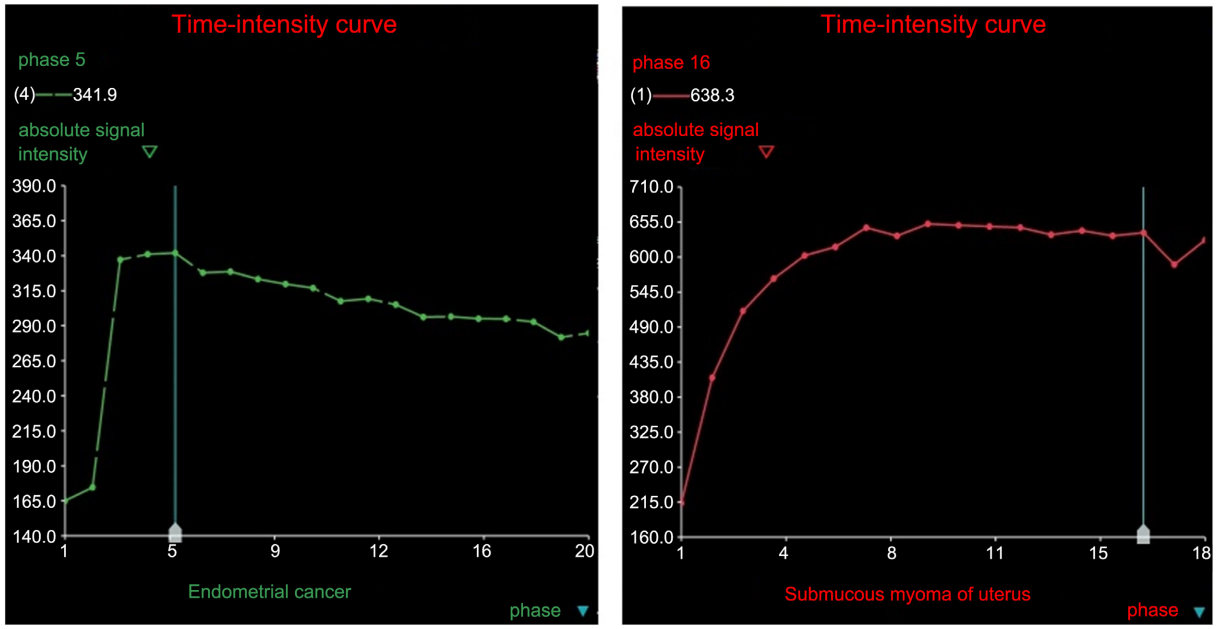

Figure 3. Comparison of the time-intensity curves (absolute signal intensity) between endometrial carcinoma and submucous myoma of the uterus.

4. Discussion

Accurate diagnosis of submucosal uterine fibroids and endometrial carcinoma is crucial for developing appropriate treatment strategies. This study demonstrates

the significant value of CE-T1WI and DWI radiomics features in their diagnosis.

In terms of CE-T1WI enhancement characteristics, our findings are consistent with previous studies [11] [12]. Endometrial carcinoma, with its abundant but immature neovascularization and high vascular permeability, often shows slower contrast agent uptake in the arterial phase, resulting in lower enhancement compared to the myometrium [13]. In contrast, submucosal fibroids, with their rich and regular vascular supply, exhibit diverse enhancement patterns, sometimes higher or slightly higher than the myometrium [14]. In the venous phase, as contrast distribution stabilizes, endometrial carcinoma typically shows lower enhancement, while submucosal fibroids exhibit more complex enhancement patterns, with a higher proportion of cases showing enhancement above the myometrium [15].

DWI, as a functional imaging technique, reflects the microscopic motion of water molecules in tissues. Endometrial carcinoma, with its high cellular density and small extracellular space, often shows significant diffusion restriction [16] [17]. ADC values quantitatively reflect the degree of water molecule diffusion, with values > 1 typically indicating benign lesions and values < 1 suggesting malignancy [18]. In this study, the ADC values in the endometrial carcinoma group were significantly lower than those in the submucosal fibroid group, further confirming the diagnostic value of DWI [19] [20].

However, no significant difference was observed in time-signal curve types between the two groups, possibly due to the relatively small sample size and tumor heterogeneity [21]. Different tumor cell types, growth patterns, and vascular supply may contribute to the diversity of time-signal curves, necessitating larger sample sizes and more detailed subgroup analyses [22]. Additionally, radiomics feature extraction and analysis are influenced by various factors, including scanner field strength, sequence parameters, contrast agent dosage, and injection rate [23] [24]. Although we standardized scanning conditions, subtle differences between scanners may still affect result accuracy [25]. Furthermore, the feature selection and model construction methods used in this study may not be optimal, and future research could explore alternative algorithms and strategies to improve diagnostic accuracy and stability [26] [27].

In clinical practice, our findings provide new imaging evidence for differentiating submucosal uterine fibroids from endometrial carcinoma. Combining CE-T1WI and DWI radiomics features may improve diagnostic accuracy and reduce unnecessary invasive procedures [28] [29]. However, challenges such as data standardization and feature interpretability remain, requiring further research and exploration [30].

5. Conclusion

This study demonstrates that CE-T1WI and DWI radiomics features can effectively differentiate submucosal uterine fibroids from endometrial carcinoma, providing valuable support for clinical diagnosis. However, the limited sample

size necessitates further validation with larger cohorts. Optimizing scanning protocols and feature extraction processes will enhance result accuracy and reproducibility, ultimately improving clinical utility.

6. Study Limitations

The small sample size may limit the generalizability of the results. Subtle differences in scanning equipment may affect radiomics feature extraction. The feature selection and model construction methods used may not be optimal, potentially limiting model performance and diagnostic accuracy.

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Conflicts of Interest

All authors declare no conflicts of interest related to this study. The research was conducted without any commercial sponsorship or influence, ensuring the objectivity and integrity of the results.

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