

Radiomics and Artificial Intelligence for Predicting PitNET Consistency: A Systematic Review and Meta Analysis



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Introduction

Pituitary neuroendocrine tumors (PitNETs) represent approximately 16% of primary brain tumors. The tumor's consistency, whether soft or fibrous, significantly impacts surgical planning and outcomes. Radiomics shows potential for predicting this consistency and assessing surgical outcomes, although its predictive accuracy is still under investigation.

This article aims to conduct a systematic review of the literature and metaanalysis on the utility of artificial intelligence and radiomics to predict the consistency of PitNETs.

Figure 1. Radiomics process.



Radiomic feature extraction Tumor intensity

Results

- Nine studies were included, covering 947 patients with PitNETs who • underwent tumor consistency prediction using radiomics.
- 66.8% had soft tumors and 33.2% had firm tumors.
- MRI machines with varying magnetic field strengths (1.5T and 3T) and different regions of interest (2D and 3D) were used across studies, with manual segmentation being the most common method.
- Prediction models demonstrated AUC values ranging from 0.71 to 0.99.
- The RQS averaged 14.2 (39.5%), and the QUADAS-2 tool revealed a varied \bullet risk of bias, mainly in patient selection and flow/timing domains, though applicability concerns were minimal.
- Meta-analysis showed that algorithms had an overall accuracy of 84% in predicting tumor consistency, with a pooled sensitivity of 84%, specificity of



Methods and Materials

- A systematic review and meta-analysis was conducted and reported following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.
- Four databases were searched for published literature on PitNET consistency prediction using radiomics and/or artificial intelligence.
- Data extraction was carried out independently by two reviewers, and findings were synthesized through narrative analysis and comparative assessment.
- The risk of bias and applicability concerns of the included studies were lacksquareassessed using the Quality Assessment of Diagnostic Accuracy Studies 2 (QUADAS-2). The Radiomics Quality Score (RQS) for each study was calculated to assess adherence to established best practices.

78%, and an AUC of 0.89, despite significant heterogeneity among studies.

Figure 4. Meta-analysis forest plot graphics.

Pooled accuracy										Weight	Weight
Study	(TN+	TP)	(TN+TP+FN+FI	P)		Propo	ortion	95%	∕₀–CI	(common)	(random)
Wan 2022		42	4	18			0.88	[0.75; (0.95]	9.4%	15.4%
Zeynalova 2019 ł	nard consistency	58	8	30			0.72	[0.61; 0	0.82]	8.6%	14.9%
Cuocolo 2020	-	26	2	28		_	0.93	[0.76; 0	0.99	9.0%	15.2%
Fan 2019		45	5	58			0.78	[0.65; 0	0.87]	7.1%	13.9%
Wang 2021		139	17	70			0.82	[0.75; 0	0.87]	24.4%	19.6%
Zhu 2020		139	15	52	- +		0.91	[0.86; (0.95]	41.5%	21.1%
Common effect	Common effect model			86	\$		0.86	[0.83; ().89]	100.0%	
Random effects	Random effects model				\diamond	_	0.84	[0.78; 0).91]	-	100.0%
Heterogeneity: I^2 =	Heterogeneity: $I^2 = 74\%$, $\tau^2 = 0.0043$, $p < 0.01$										
					0 0.2 0.4 0.6 0.8	1					
<u>Sensitivity</u>									۱۸	laight M	laight
Study		TP (TP+FN)		P	roportion	95	5%–Cl	(com	imon) (ran	dom)
Fiore 2023		52	64		_	0.81	[0.70	; 0.90]	-	12.9% 1	2.0%
Wan 2022		40	48			0.83	0.70	0.93	-	10.6% 1	1.1%
Rui 2019 neo	ative features	47	53			0.89	10.77	0.961	-	16.2% 1	3.0%
Rui 2019 pos	, itive featurs	45	53			0.85	0.72	0.93	-	12.7% 1	2.0%
Zevnalova 20	19 hard consistency	25	38			0.66	[0.49	0.801		5.2%	7.7%
Zevnalova 20	19 soft consistency	33	42		ia 1	0.79	[0.63	0.901		7.6%	9.6%
Su 2020		39	50			0.78	[0.64	0.881		8.9%	0.3%
)	13	13			1 00	[0 75	1 001	-	12.4%	1.9%
Fan 2019	-	49	58		2	0.84	[0 73	0.931	-	13.5%	2.3%

Fan 2019	49	58						-	0.84 [0.73; 0.93]	13.5%	12.3%
Common effect model		419					~		0.85 [0.81; 0.88]	100.0%	-
Random effects model							\diamond		0.84 [0.78; 0.89]	-	100.0%
Heterogeneity: $I^2 = 58\%$, $\tau^2 = 0.0$	0040, $p = 0.0^{-1}$	1			I						
			0	0.2	0.4	0.6	0.8	1			

Specificity

										Weight	Weight
	Study	TN (TN	+FP)					Proportion	95%-CI	(common)	(random)
	Fiore 2023	55	64				<u> </u>	0.86	[0.75; 0.93]	18.0%	12.9%
	Wan 2022	42	48				<u> </u>	0.88	[0.75; 0.95]	14.9%	12.4%
	Rui 2019 negative features	32	53			_		0.60	[0.46; 0.74]	7.5%	10.5%
	Rui 2019 positive featurs	36	53					0.68	[0.54; 0.80]	8.3%	10.8%
	Zeynalova 2019 hard consistency	33	42					0.79	[0.63; 0.90]	8.5%	10.9%
	Zeynalova 2019 soft consistency	25	38			-		0.66	[0.49; 0.80]	5.7%	9.5%
	Su 2020	46	50					0.92	[0.81; 0.98]	23.1%	13.3%
	Cuocolo 2020	13	15					0.87	[0.60: 0.98]	4.4%	8.5%
	Fan 2019	41	58					0.71	[0.57; 0.82]	9.5%	11.2%
	Common effect model Bandom effects model		421					0.81 0.78	[0.77; 0.85] [0.70: 0.85]	100.0%	
	Heterogeneity: $l^2 = 75\%$, $\tau^2 = 0.0096$, <i>p</i> < 0.01			Γ	T				-	
				0	0.2	0.4	0.6 0.8 1				
Positive p	predictive value										
	Otherster							Ducucution		weight	weight
	Study	IP (IP	+FP)					Proportion	95%-CI	(common)	(random)
	Rui 2019 negative features	37	53				<u> </u>	0.70	[0.56; 0.82]	19.2%	18.3%
	Rui 2019 positive features	39	53					0.74	[0.60; 0.85]	20.8%	19.1%
	Zeynalova 2019 hard consistency	25	38			-		0.66	[0.49; 0.80]	12.9%	14.5%
	Zeynalova 2019 soft consistency	33	42					0.79	[0.63; 0.90]	19.0%	18.2%
	Cuocolo 2020	13	15					0.87	[0.60; 0.98]	9.9%	12.2%
	Fan 2019	34	58					0.59	[0.45; 0.71]	18.2%	17.8%
	Common effect model		259				\diamond	0.71	[0.66: 0.77]	100.0%	
	Bandom effects model		200				$\dot{\diamond}$	0.72	[0 64: 0 79]	1001070	100.0%
	Heterogeneity: $l^2 = 44\%$ $\tau^2 = 0.0034$	p = 0.11						0.1 -		•	
		, <i>p</i> = 0.11		0	0.2	0.4	0.6 0.8 1				
Negative	predictive value										
										Weiaht	Weight
	Study	TN (TN-	⊦FN)					Proportion	95%–CI (common) (I	random)
	Rui 2019 negative features	45	53				i	0.85	0.72: 0.931	18.7%	17.7%
	Rui 2019 positive features	43	53				_	0.81	0.68: 0.911	15.7%	16.9%
	Zevnalova 2019 hard consistency	33	42					0.79	0.63: 0.901	11.3%	15.4%
	Zevnalova 2019 soft consistency	25	38					0.66	[0.49; 0.80]	7.6%	13.3%
		13	13					1.00	0.75; 1.00]	18.4%	17.6%
	Fan 2019	52	58					0.90	0.79; 0.96]	28.3%	19.1%
			057						-	100.00/	
	Common effect model		257					0.86 [0.82; 0.90]	100.0%	
	Handom effects model	- -						0.84 [0.76; 0.93]	-	100.0%
	Heterogeneity: $I^{-} = 72\%$, $\tau^{-} = 0.0084$,	<i>p</i> < 0.01		ı c		,					
				0	0.2	0.4	0.6 0.8 1				

Meta-analysis was conducted using random-effects modeling and visualized using forest plots.



Limitations

The evolving nature of radiomics technology necessitates further research, particularly studies with larger populations and rigorous internal validation, to refine and validate predictive models. Significant heterogeneity in reporting outcomes.

Conclusions

This study demonstrates the promising potential of radiomics, particularly when combined with artificial intelligence, in the study of neurological tumors, with a focus

on predicting the consistency of PitNETs. By distinguishing between soft and firm tumors, radiomics can significantly enhance preoperative planning, influence surgical approaches, and reduce complications, ultimately leading to better surgical outcomes.

Contact

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Access QR code for: complete references list, tables and figures.



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