

Avoid misdiagnosis of sarcoma as benign peripheral nerve sheath tumor by using multiple magnetic resonance imaging features

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Background: Myxomatous soft tissue sarcoma can be misdiagnosed as benign peripheral nerve sheath tumor (BPNST), which usually underwent excision without histological confirmation, due to misinterpret magnetic resonance (MR) characteristics.

Purposes: The aim of this study was to demonstrate diagnostic value and reliability of specific MR features for diagnosing BPNST in myxomatous and cystic-like soft tissue tumor.

Patients and Methods: One-hundred and forty-seven MR images (76 myxomatous sarcomas, 45 BPNSTs, and 26 benign cystic tumors) were retrospectively reviewed by two musculoskeletal radiologists who were blinded to actual pathology. Six BPNST-specific and thirteen sarcoma-specific features were investigated including spindle shape, tail sign, target sign, split fat sign, fascicular sign, encapsulation, irregular shape, size, depth, T1-weighted signal, T1 homogeneity, T2 homogeneity, hemorrhage, calcification, infiltrative margin, necrosis, lobulation, perilesional edema, and peripheral Gadolinium-enhancement pattern. Pooled sensitivity, specificity and diagnostic odd ratio (DOR) were calculated by R statistical software with meta-analysis of diagnostic accuracy package (MADA). The parameters, those were statistically significant in univariate analysis, kappa value more than 0.4, and confidence interval of diagnostic odd ratio did not cover 1, were included in logistic regression analysis.

Results: The accuracy indexes of MRI features were illustrated (table 1). From logistic regression model (table 2), the MR parameters that should be considered when diagnose BPNST were spindle shape, tail sign, target sign, split fat sign, size less than 5 cm, superficial to fascia, homogeneous pattern in T1-weighted signal, and absence of perilesional edema. The pooled sensitivity and specificity for this model were 84.9 % and 95.6 % respectively and the area under receiver operator curve was 0.97.

Table. 1 Inter-observer agreement value, pooled accuracy indexes and p-value of BPNST and sarcoma specific MR characteristics

MRI feature	Kappa value	Accuracy indexes for diagnosing BPNST			p-value	
		Pooled Sensitivity(95%CI)	Pooled Specificity(95%CI)	DOR (95%CI)	Data 1	Data2
Spindle	0.60	92.3%(84-96.4)	51.5%(37.2-65.5)	12.15(5.03-29.35)	<0.001	<0.001
Tail sign	0.87	71.1%(60.9-79.5)	95.6%(91.7-97.7)	53.77(23.89-121.04)	<0.001	<0.001
Target sign	0.48	38%(28.7-48.3)	97.3%(93.1-99)	30.38(5.34-172.97)	<0.001	<0.001
Split fat sign	0.56	67.8%(53.8-79.3)	89.8%(82.6-94.2)	18.49(6.6-51.8)	<0.001	<0.001
Fascicular sign	0.33	28.3%(6.1-70.3)	98.3%(93-99.6)	26.17(8.67-79.03)	0.001	<0.001
Encapsulation	0.20	83.6%(7.6-99.7)	52.1%(27.7-75.6)	5.08(0.24-109.34)	<0.001	0.585
Irregular shape	0.60	48.7%(31.3-66.3)	74.6%(81.1-66.9)	2.79(1.34-5.8)	<0.001	0.049
Size more than 5 cm	0.89	73%(65.4-79.5)	64.1%(55.9-71.5)	4.83(2.94-7.94)	<0.001	<0.001
Deep to muscle fascia	0.86	84.2%(77.5-89.2)	38%(30.4-46.3)	3.27(1.88-5.68)	0.001	0.004
Intermediate T1W	0.38	75.6%(68.1-81.8)	50%(42.3-57.7)	3.11(1.92-5.03)	<0.001	0.039

signal						
Heterogeneous T1 signal	0.62	62.5%(54.5-69.8)	78.8%(71.3-84.8)	6.21(3.69-10.45)	<0.001	<0.001
Heterogeneous T2 signal	0.44	79.7%(62-90.4)	56.4%(22.8-84.9)	5.21(2.67-10.14)	0.001	<0.001
Hemorrhage	0.57	39.8%(22.5-60.1)	94.5%(87.8-97.6)	11.75(5.34-25.87)	<0.001	<0.001
Calcification	0.59	3%(1.1-7.7)	95.5%(90.4-98)	0.61(0.17-2.24)	0.520	0.631
Invasive margin	0.93	53.9%(46-61.7)	98.6%(94.5-99.6)	82(19.6-343.25)	<0.001	<0.001
Necrosis	0.51	41.5%(32.5-51.1)	95.1%(89.8-97.7)	13.82(6.04-31.59)	<0.001	<0.001
Lobulation	0.34	71.3%(35.4-91.9)	79.3%(18.1-98.5)	9.25(2.39-35.84)	<0.001	<0.001
Perilesional edema	0.65	81.3%(66.2-90.7)	85.4%(74.8-92)	26.39(13.98-49.81)	<0.001	<0.001
Heterogeneous Gd-Enhancement	0.42	74.9%(33.7-94.6)	39.8%(18.3-66.2)	1.89(0.93-3.83)	0.048	0.226
Peripheral Gd-Enhancement	0.58	11.1%(10-23.1)	84.5%(90-76.9)	0.692(0.20-2.38)	0.069	0.657

BNPST- Benign peripheral nerve sheath tumor

CI- Confidence interval

DOR- Diagnostic odd ratio

Table. 2 Coefficient, odd ratio and p-value of significant MRI characteristic for diagnosing BPNST from multivariate logistic regression analysis of data set 1&2

MRI feature	Radiologist 1			Radiologist 2		
	Coefficient	Odd ratio(95%CI)	p-value	Coefficient	Odd ratio(95%CI)	p-value
Spindle shape	2.749	15.62(1.99-122.89)	0.009	1.876	6.53(0.92-46.21)	0.06
Tail sign	2.477	11.9(2.25-62.93)	0.004	3.774	43.59(6.76-280.49)	<0.001
Target sign	0.533	1.7(0.14-20.19)	0.673	21.013	∞	0.998
Split fat sign	2.698	14.85(2.04-108.29)	0.008	1.532	4.63(0.71-30.21)	0.109
Size less than 5 cm	2.171	8.77(1.38-55.61)	0.021	-0.318	0.73(0.15-3.57)	0.695
Superficial to fascia	1.007	2.74(0.46-16.28)	0.268	2.096	8.14(1.22-54.33)	0.030
Homogeneous T1W signal	2.063	7.87(0.99-62)	0.05	2.313	10.1(1.13-90.14)	0.038
Perilesional edema	-1.92	0.147(0.03-0.75)	0.021	-2.027	0.13(0.02-0.8)	0.027
Constant	-4.629	0.1	0.009	-5.784	0.003	<0.001
Hosmer – Lemeshow test	0.987			0.955		
Area under ROC (95%CI)	0.977 (0.956-0.997)			0.973(0.951-0.996)		

CI- confidence interval

Logistic regression equation: $\ln\left(\frac{P}{1-P}\right) = \text{constant} + \text{coefficient}_1 \times \text{presence of feature}_1 \dots$

\ln - natural logarithm P - Probability of BPNST

Conclusions: The accuracy of BPNST diagnosis was improved and misdiagnosis can be avoided by using combination of particular MR features.