



· 论 著 ·

基于超声征象的决策树模型在预测胃肠道间质瘤危险度中的应用价值

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[摘要] **背景与目的:** 胃肠道间质瘤 (gastrointestinal stromal tumor, GIST) 的生物危险度可分为极低危、低危、中危和高危, 术前就危险度进行准确预判对临床制订诊疗方案至关重要。探讨基于超声征象的决策树模型在预测GIST危险度中的应用价值。**方法:** 收集福建医科大学附属协和医院2016年12月—2020年12月收治的206例GIST患者, 建立决策树模型, 并判断模型预测的准确度。**结果:** 低危、中危和高危3组间病灶长径、短径/长径 (short diameter/long diameter, S/L)、肿瘤部位、回声高低、回声均匀性、边界、形态、是否坏死囊变和血流信号的差异均有统计学意义 (P 均 <0.05)。以病灶长径、肿瘤部位、回声均匀性及形态为节点建立的决策树模型预测的准确度为72.33%, 其中低危组和高危组预测的准确度可高达80.90%和93.90%。**结论:** 以超声特征为主要指标构建的决策树模型在预测GIST危险度中具有较高的应用价值。

[关键词] 胃肠道间质瘤; 危险分级; 决策树; 超声

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Application value of decision tree model based on ultrasonic signs in predicting the risk grade of gastrointestinal stromal tumors GUO Jingjing, TANG Xiubin, CHEN Lei, QIAN Qingfu, LIN Liwu, XUE Ensheng, CHEN Zhikui (Department of Ultrasound, Union Hospital Affiliated to Fujian Medical University, Fuzhou 350001, Fujian Province, China)

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[Abstract] **Background and purpose:** The biological risk of gastrointestinal stromal tumor (GIST) can be divided into very low-risk, low-risk, moderate-risk and high-risk. Accurate preoperative prediction of risk is very important for clinical diagnosis and treatment. This study explored the application value of decision tree model based on ultrasonic signs in predicting the risk grade of GIST. **Methods:** A total of 206 GIST patients treated in Union Hospital Affiliated to Fujian Medical University from December 2016 to December 2020 were collected. The decision tree model was established, and the prediction accuracy of the model was calculated. **Results:** There were statistically significant differences in long diameter, short diameter/long diameter (S/L), location, internal echo, echo uniformity, boundary, shape, cystic necrosis and blood flow signals among low-risk, moderate-risk and high-risk groups (all $P < 0.05$). The prediction accuracy of the decision tree model based on the long diameter, location, echo uniformity and shape was 72.33%, and the prediction accuracies of the low-risk group and high-risk group were 80.90% and 93.90%, respectively. **Conclusion:** The decision tree model based on ultrasonic signs has high application value in predicting the risk grade of GIST.

[Key words] Gastrointestinal stromal tumor; Risk grade; Decision tree; Ultrasonography

胃肠道间质瘤 (gastrointestinal stromal tumor, GIST) 是最常见的胃肠道黏膜下肿瘤^[1-2], 病灶的危险度分类被认为与肿瘤术后复

发、预后密切相关^[3], 术前就危险度进行准确预判对临床制订诊疗方案至关重要。超声检查不但可以在术前较准确地诊断GIST, 还是分子靶向

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药物治疗后随访的重要影像学手段^[4-5]。

决策树是一种基于样本学习后构建的分类器,也是一种预测模型,被广泛应用于风险评估、收益评估和疾病预测^[6-7]。本研究计划构建基于超声征象的决策树模型,探讨其在预测GIST危险度中的应用价值。

1 资料和方法

1.1 一般资料

采用回顾性队列研究,收集2016年12月—2020年12月福建医科大学附属协和医院经外科手术后病理学检查证实的GIST患者206例,共206个病灶。纳入标准为:①外科切除后病理学检查证实为GIST,并且进行危险度分级;②术前2周内行经腹部或经直肠腔内超声检查。排除标准为:①活检标本或行靶向药物治疗,无法进行危险度评级;②术前未行超声检查。本研究经福建医科大学附属协和医院伦理委员会批准,豁免知情同意。

1.2 仪器与方法

使用日本Hitachi公司Hivision Preirus、日本Toshiba公司Aplio 500等彩色多普勒超声诊断仪。经腹部超声检查使用凸阵探头(频率3~6 MHz),空腹至少8 h,检查前饮水或胃肠超声显像剂500~800 mL。经直肠腔内超声检查使用高频端扫式探头或360°环阵探头(频率4~10 MHz),检查前常规行肠道准备。

1.3 观察指标

①人口学特征:性别、年龄;②超声指标:病灶内部回声(低回声、等回声)、回声均匀性(均匀、不均匀)、边界(清楚、不清楚)、形态(规则、不规则)、血流信号(Alder 0级、1级、2级和3级)、是否出现坏死囊变、病灶长径(≤ 2.0 cm、 > 2.0 cm且 ≤ 5.0 cm、 > 5.0 cm且 ≤ 10.0 cm、 > 10.0 cm),计算病灶短径/长径(short diameter/long diameter, S/L)。

1.4 统计学处理

使用SPSS 26.0软件对数据进行分析,对连续型变量采用Kruskal-Wallis秩和检验,对分类变量采用 χ^2 检验或Fisher确切概率法,筛选出不同组间存在差异的指标;以危险度为因变量,将单因素分析筛选出来的指标纳入建立决策树,所有病例纳入训练集,并进行危险度预测。 $P < 0.05$ 为差异有统计学意义, $P < 0.01$ 为差异有显著统计学意义。3组之间的两两比较, P 值经过Bonferroni校正, $P < 0.0167$ 为差异有统计学意义, $P < 0.003$ 为差异有显著统计学意义。

2 结果

206例患者的年龄为28~86岁,平均年龄(60.5 ± 10.8)岁,低危、中危和高危3组的中位年龄分别为63.0、62.0和61.0岁,3组病灶S/L的中位数分别约为0.80、0.84和0.70,不同危险度组各指标结果见表1。

表1 不同危险度组GIST各指标结果

Tab. 1 The results of GIST indicators between the different risk groups

Indicator	Low-risk group (n=89)	Moderate-risk group (n=35)	High-risk group (n=82)	Total (n=206)
Gender				
Male	49	23	51	123
Female	40	12	31	83
Long diameter D/cm				
≤ 2.0	26	8	6	40
2.0-5.0	60	21	17	98
5.0-10.0	3	6	19	28
> 10.0	0	0	40	40
Tumor source location				
Stomach	70	35	47	152
Outside the stomach	19	0	35	54
Echo uniformity				
Homogeneous	63	9	13	85
Heterogeneous	26	26	69	121

续表 1

Indicator	Low-risk group (n=89)	Moderate-risk group (n=35)	High-risk group (n=82)	Total (n=206)
Internal echo				
Hypoecho	87	29	74	190
Isoecho	2	6	8	16
Shape				
Regular	55	12	13	80
Irregular	34	23	69	126
Boundary				
Clear	83	31	60	174
Unclear	6	4	22	32
Necrotic cystic degeneration				
Positive	11	15	54	80
Negative	78	20	28	126
Blood flow signals				
Level 0	55	22	16	93
Level 1	24	11	24	59
Level 2	6	2	18	26
Level 3	4	0	24	28

不同危险度组间的年龄 ($H=0.733$, $P=0.693$) 和性别 ($\chi^2=1.536$, $P=0.464$) 差异无统计学意义。不同危险度组间的病灶长径 ($H=104.904$, $P<0.001$)、S/L ($H=10.145$, $P=0.006$)、肿瘤部位 ($\chi^2=25.022$, $P<0.001$)、病灶内部回声

($\chi^2=8.533$, $P=0.014$)、回声均匀性 ($\chi^2=57.343$, $P<0.001$)、边界 ($\chi^2=13.667$, $P<0.001$)、形态 ($\chi^2=38.294$, $P<0.001$)、坏死囊变 ($\chi^2=51.703$, $P<0.001$) 和血流信号 ($H=51.529$, $P<0.001$) 差异有统计学意义 (表2, 图1)。

表 2 不同危险度组间指标的两两比较

Tab. 2 The comparison of indicators in different risk groups

Indicator	Low-risk group vs moderate-risk group		Moderate-risk group vs high-risk group		Low-risk group vs high-risk group	
	Statistic of test	P value	Statistic of test	P value	Statistic of test	P value
Long diameter ^b	-13.062	0.240	-61.837	0.000	-74.900	0.000
S/L ^b	-0.837	0.944	27.516	0.022	26.679	0.003
Tumor source location ^a	8.824	0.004	21.315	0.000	8.991	0.003
Internal echo ^c	NA	0.006	NA	0.350	NA	0.050
Echo uniformity ^a	20.959	0.000	1.562	0.301	52.159	0.000
Boundary	NA	0.466 ^c	3.366 ^a	0.089 ^a	12.577 ^a	0.000 ^a
Shape ^a	7.656	0.009	4.960	0.030	37.611	0.000
Necrotic cystic degeneration ^a	14.100	0.000	5.362	0.025	51.831	0.000
Blood flow signals ^b	4.365	0.696	-60.184	0.000	-55.819	0.000

a: χ^2 test. b: Kruskal-Wallis rank sum test for independent samples. c: Fisher's exact probability method. The P value is corrected by Bonferroni; NA: Not available.

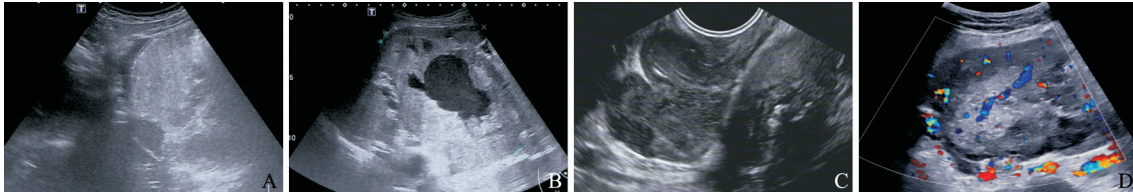


图 1 不同部位及危险度的GIST超声表现

Fig. 1 The ultrasonic findings of GIST with different locations and risk grades

A: Low-risk gastric stromal tumor; B: High-risk gastric stromal tumor; C: High-risk rectal stromal tumor; D: High-risk mesostenium stromal tumor.

将病灶长径、S/L、肿瘤部位、病灶内部回声、回声均匀性、边界、形态、坏死囊变和血流信号纳入建立决策树模型，得出以病灶长径、肿瘤部位、回声均匀性、形态为分类节点的决策树

模型，模型以病灶长径为根节点，最大树深度为3层（图2）。决策树模型预测GIST危险度总的准确度为72.33%（149/206），其中对低危组和高危组预测的准确度分别达80.90%（72/89）和

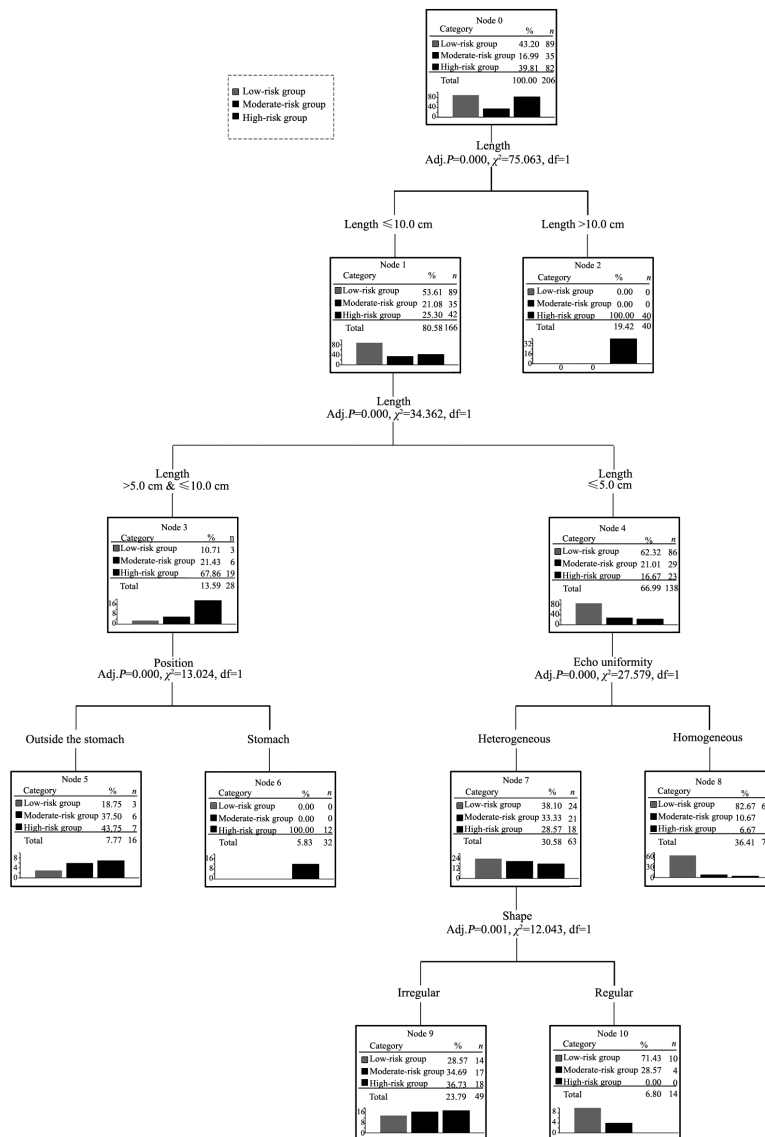


图 2 基于超声征象的预测GIST危险度的决策树模型

Fig. 2 Decision tree model based on ultrasonic signs for predicting the risk grade of GIST

93.90% (77/82), 而对中危组预测的准确度为0.00%。决策树模型预测本组GIST危险度与病理学检查结果的对照见表3。

表3 决策树模型预测GIST危险度与病理学检查结果的对照

Tab. 3 Comparison of the prediction by decision tree model and pathology

Prediction	Pathology			Total
	Low-risk	Moderate-risk	High-risk	
Low-risk	72	12	5	89
Moderate risk	0	0	0	0
High-risk	17	23	77	117
Total	89	35	82	206

3 讨 论

目前超声在GIST方面的研究主要集中在超声内镜下的诊断、治疗及预后评价等^[8-10], 但超声内镜穿透力低, 难以完整显示外生型的大病灶, 而经腹胃肠造影能够充分充盈胃腔, 清楚显示胃壁层次结构, 判断肿瘤与胃壁的关系, 达到近似超声内镜下的图像质量, 经直肠超声探头频率高, 能够清楚判断肿瘤与肠壁的关系, 本研究即采用经腹胃肠造影及经直肠超声检查两种方法获取病灶超声征象, 包括长径、短径/长径、肿瘤部位、回声高低、回声均匀性、边界、形态、是否出现坏死囊变和血流信号。将上述肿瘤的超声征象及患者年龄、性别进行单因素分析, 结果发现, 不同危险度组间的年龄和性别差异无统计学意义, 而不同危险度组间的长径、短径/长径、肿瘤部位、回声高低、回声均匀性、边界、形态、是否出现坏死囊变和血流信号存在差异。

原发可切除GIST术后风险评估系统有多种, 其中以美国国立卫生研究院(2008改良版)应用最为广泛^[11]。GIST的发生位置和大小作为影响预后的重要因素, 被美国国立卫生研究院分级系统列为危险度分级指标。研究^[12]表明, GIST病灶越大, 其发生浸润的风险越高。本组高危组>10 cm的病灶显著多于低危组(0%)和中危组(0%), 占48.78%(40/82)。发生在胃外的GIST具有更高的生物危险度, 如十二指肠间质瘤的生物学行为为恶性的发生率是胃间质瘤

的两倍, 肿瘤容易破裂造成出血甚至引起肠瘘等^[12-16]。该研究中, 高危组内胃外间质瘤占比约为42.68%(35/82), 显著高于低危组和中危组, 与文献报道^[15]相符。

GIST体积较小时, 镜下绝大多数为梭形细胞型^[17-18], 成分单一, 超声呈现为均匀低回声病灶。当病灶增大, 瘤内出现微小的坏死囊变灶, 使得内部回声增高, 往往提示GIST具有更高生物危险度的可能性。本研究中, 高危组84.15%(69/82)的病灶内部回声不均, 65.85%(54/82)出现坏死囊变, 中危组74.29%(26/35)的病灶内部回声不均, 42.86%(15/35)出现坏死囊变, 均显著高于低危组。由于GIST可压迫周围组织形成假包膜, 超声表现为病灶边界清楚、形态规则。GIST生物学行为呈恶性时, 可侵犯周围组织, 出现边界不清晰。本研究中, 高危组26.83%(22/82)的病灶边界不清, 84.15%(69/82)形态不规则, 显著高于低危组。GIST生物学行为呈良性时, 血流信号较为稀少, 多位于肿瘤周边, 而生物学行为呈恶性者, 则呈现为从外围到中央的丰富血流信号, 通过观察肿瘤的血供有助于评估GIST的恶性潜能^[19]。本研究中, 高危组约29.27%为3级血流信号, 显著高于低危组(4.49%)和中危组(0.00%)。

本研究构建的决策树模型, 最终纳入病灶长径、肿瘤部位、回声均匀性及形态4个指标, 模型以病灶长径为根节点, 最大树深度为3层。其预测GIST危险度总的准确度为72.33%, 其中低危组和高危组预测的准确度较高, 分别达80.90%和93.90%, 而对于中危组预测能力差, 分析可能的原因如下: ①中危组作为低危组和高危组之间的一种过渡类型, 容易出现良恶性超声征象的混叠, 造成超声预测危险度的准确度低; ②该研究纳入的中危组病例量较少, 可能对统计结果产生一定影响。

综上所述, 以病灶长径、肿瘤部位、回声均匀性及形态为节点建立的决策树模型对低危险度和高危险度GIST预测的准确度较高, 在预测GIST危险度中具有较高的应用价值。

利益冲突声明: 所有作者均声明不存在利益冲突。

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