

• 论 著 •

磁共振成像在诊断肩袖损伤中的临床价值

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[摘要] 目的 探讨磁共振成像(magnetic resonance imaging, MRI)在诊断肩袖损伤中的临床价值。方法 选取疑似肩袖损伤患者120例,均给予MRI检查,分析MRI诊断肩袖损伤的价值,同时确诊的肩袖损伤患者给予非手术治疗,比较治疗有效和无效患者临床影像资料。结果 MRI诊断肩袖损伤的敏感度、特异度、准确率、阳性预测值和阴性预测值分别为98.04%、94.44%、97.50%、99.01%和89.47%。斜冠状位扫描冈下肌腱损伤和肩胛下肌腱损伤检出率分别为52.94%和49.02%,明显低于轴位和斜矢状位扫描($P < 0.05$);斜矢状位扫描冈上肌腱损伤检出率为77.45%,明显低于斜冠状位扫描($P < 0.05$);轴位和斜冠状位扫描小圆肌腱损伤检出率分别为7.84%和13.73%,明显低于斜矢状位扫描($P < 0.05$)。治疗无效患者年龄为(65.54±7.03)岁、冈上肌回缩距离为(24.41±5.93)mm,明显高于治疗有效患者($P < 0.05$);治疗无效患者肩胛下肌撕裂程度明显重于治疗有效患者($P < 0.05$),其完全撕裂比例为80.95%。Logistic回归分析显示:年龄、肩胛下肌撕裂程度是肩袖损伤患者非手术治疗效果的影响因素($P < 0.05$)。构建Logistic回归模型,该模型预测治疗无效的ROC曲线下面积为0.813(95%CI: 0.728~0.898, $P < 0.05$),敏感度和特异度分别为88.00%和64.50%。结论 MRI在诊断肩袖损伤中有较高的敏感度和特异度,同时MRI参数—肩胛下肌撕裂程度与患者非手术治疗效果有关,值得进一步研究。

[关键词] 回旋套损伤;磁共振成像;诊断 doi:10.3969/j.issn.1007-3205.2025.01.018

[中图分类号] R684.7 **[文献标志码]** A **[文章编号]** 1007-3205(2025)01-108-05

Clinical value of magnetic resonance imaging in the diagnosis of rotator cuff injury

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[Abstract] **Objective** To explore the clinical value of magnetic resonance imaging (MRI) in the diagnosis of rotator cuff injury. **Methods** One hundred and twenty patients with suspected rotator cuff injury were selected, and all of them were given MRI examination, to analyze the value of MRI in the diagnosis of rotator cuff injury. In the meantime, patients with confirmed rotator cuff injury were given non-surgical treatment, and the difference of clinical imaging data between patients with effective and ineffective treatment were compared. **Results** The sensitivity, specificity, accuracy, positive predictive value and negative predictive value of MRI in diagnosing rotator cuff injury were 98.04%, 94.44%, 97.50%, 99.01% and 89.47%, respectively. The detection rates of infraspinatus tendon injury and subscapular tendon injury in oblique coronal scan were 52.94% and 49.02%, respectively, which were significantly lower than those in axial and oblique sagittal scan ($P < 0.05$). The detection rate of supraspinatus tendon injury in oblique sagittal scan was 77.45%, which was significantly lower than that in oblique

[收稿日期]2023-09-04

[基金项目]廊坊市科学技术研究与发展计划(2022013021)

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coronal scan ($P < 0.05$). The detection rates of teres minor tendon injury in axial and oblique coronal scan were 7.84% and 13.73%, respectively, which was significantly lower than those in oblique sagittal scan ($P < 0.05$). The age of patients with ineffective treatment was (65.54 ± 7.03) years, and the retraction distance of supraspinatus muscle was (24.41 ± 5.93) mm, which were significantly higher than those in patients with effective treatment ($P < 0.05$). The degree of subscapular muscle tear in patients with ineffective treatment was significantly greater than that in patients with effective treatment ($P < 0.05$), and the complete tear ratio was 80.95%. Logistic regression analysis showed that age, and degree of subscapular muscle tear were the influencing factors of non-surgical treatment effect in patients with rotator cuff injury ($P < 0.05$). Logistic regression model was constructed, and the area under the ROC curve of the model in predicting ineffective treatment was 0.813 (95% CI: 0.728–0.898, $P < 0.05$), with sensitivity and specificity of 88.00% and 64.50%, respectively. **Conclusion** MRI has high sensitivity and specificity in the diagnosis of rotator cuff injury, and the MRI parameter, subscapular muscle tear, is related to the effect of non-surgical treatment, which is worthy of further study.

[Key words] rotator cuff injuries; magnetic resonance imaging; diagnosis

肩袖是稳定和支持肩关节活动的主要解剖结构,肩袖损伤是成年人肩部关节痛和活动受限最常见的原因^[1-2]。肩袖损伤临床常常表现为肩袖部分肌肉肌腱断裂,引发患者肩部明显疼痛,长此以往将会影响到患者的生活质量。既往对肩袖损伤常用等临床诊断方法为X线,CT和关节造影,虽然可以提供相应的影像学诊断依据,但其分辨率过低,准确率也较差,无法作出明确诊断^[3-6]。磁共振成像(magnetic resonance imaging, MRI)具有安全性高、无辐射、分辨率高等优势,其中的T2WI和脂肪抑制序列目前常作为诊断肩袖损伤的主要依据,可准确评估肩袖损伤和撕裂情况^[7-9]。因此,本文通过对疑似肩袖损伤患者进行MRI检查,旨在探讨MRI在诊断肩袖损伤中的临床价值。

1 资料与方法

1.1 一般资料 选取2021年1月—2023年2月在我院就诊的疑似肩袖损伤患者120例,其中男性69例,女性33例;年龄43~81岁,平均(63.35 ± 6.94)岁。纳入标准:①主诉有肩关节疼痛、压痛及活动受限;②年龄 ≥ 18 岁;③单侧发病;④在我院接受非手术治疗;⑤依从性高,能配合检查及治疗者;⑥患者及家属知情同意。排除标准:①有类风湿关节炎、颈椎疾病者;②有肩部手术、骨折史;③中转行手术治疗者。

本研究经医院伦理委员会批准通过(KYLL-2022-03)。

1.2 检查方法 常规检查采用西门子 Verio 3.0T,肩关节磁共振线圈为GP-FLEX柔韧线圈。横轴面

T2WI扫描参数:重复时间(repetition time, TR) 4 400 ms,回波时间(echo time, TE) 80 ms,层厚 5 mm,层间距 0.5 mm,视野 18 cm \times 20 cm;斜矢状面 T1WI 扫描参数:TR 750 ms,TE 11 ms,其余指标同上;斜冠状面 T2WI 扫描参数:TR 3 400 ms,TE 100 ms,其余指标同上;斜矢状面 T2WI 扫描参数:TR 4 100 ms,TE 100 ms,其余指标同上。影像学评估指标为积液程度、冈上肌肌腱回缩距离、肩胛下肌腱撕裂程度、冈下肌肌腱撕裂程度、小圆肌腱撕裂程度。

1.3 图像分析 由经验丰富的2名主任医师判断120例疑似肩袖损伤患者不同扫描方位影像学资料,先采用双盲法让每位医师独立诊断,后统筹汇总,意见不一致协商诊断。肩袖损伤诊断参照《肩袖损伤的处理临床实践指南(2019年)》中的标准。

1.4 治疗及评估方法 以关节镜检查为金标准,将确诊的肩袖损伤患者经非手术治疗3个月进行效果评估,由3名副主任及以上医师评估患者肩关节功能,如仍需手术治疗者则为治疗无效,否则为治疗有效。肩袖损伤分级:I级,肌腱内未见异常信号,周围周围可见FS-T2WI高信号,肌腱周围有渗出或积液;II级,肌腱内出现FS-T2WI高信号,提示肌腱黏液变性(损伤);III级,肌腱撕裂,肌腱不连续,可见肌腱撕裂口及撕裂的肌腱回缩,代之以积液填充。

1.5 统计学方法 应用SPSS 22.0统计软件分析数据。计量资料比较采用 t 检验;计数资料比较采用 χ^2 检验,等级资料比较采用秩和检验;以临床最终诊断、关节镜检查作为“金标准”,分析MRI诊断肩袖损伤的价值。采用多因素 Logistic 回归分析肩

袖损伤患者非手术治疗效果的影响因素,模型预测价值采用 ROC 曲线分析。 $P < 0.05$ 为差异有统计学意义。

2 结 果

2.1 MRI 诊断肩袖损伤的价值 MRI 诊断肩袖损伤的敏感度、特异度、准确率、阳性预测值和阴性预测值分别为 98.04% (100/102)、94.44% (17/18)、97.50% (117/120)、99.01% (100/101) 和 89.47% (17/19),见表 1。

2.2 不同扫描方位对肩袖损伤检出情况比较 斜

表 2 不同扫描方位对肩袖损伤检出情况比较

Table 2 Comparison of detection of rotator cuff injury in different scanning directions

(n=102,例数,%)

不同扫描方位	最终诊断			
	冈上肌腱损伤检出率	冈下肌腱损伤检出率	肩胛下肌腱损伤检出率	小圆肌腱损伤检出率
轴位	85(83.33)	93(91.18)	95(93.14)	8(7.84)
斜冠状位	99(97.06)	54(52.94)*	50(49.02)*	14(13.73)
斜矢状位	79(77.45)#	90(88.24)#	87(85.29)#	82(80.39)*#
χ^2 值	17.101	52.881	61.635	147.64
P 值	<0.001	<0.001	<0.001	<0.001

* P 值<0.05 与轴位比较 # P 值<0.05 与斜冠状位比较(χ^2 检验)

2.3 肩袖损伤不同治疗效果患者临床资料、MRI 参数比较 治疗无效组年龄、冈上肌回缩距离明显高于治疗有效组,肩胛下肌撕裂程度明显重于治疗

冠状位扫描冈下肌腱损伤和肩胛下肌腱损伤检出率明显低于轴位和斜矢状位扫描($P < 0.05$);斜矢状位扫描冈上肌腱损伤检出率明显低于斜冠状位扫描($P < 0.05$);轴位和斜冠状位扫描小圆肌腱损伤检出率明显低于斜矢状位扫描($P < 0.05$)。见表 2。

表 1 MRI 诊断与最终诊断比较

Table 1 Comparison of MRI diagnosis and final diagnosis

(n=120,例数)

MRI 诊断	最终诊断	
	肩袖损伤	非肩袖损伤
肩袖损伤	100	1
非肩袖损伤	2	17

有效组,差异有统计学意义($P < 0.05$)。治疗无效组和 治疗有效组性别、体重指数等其余指标比较差异无统计学意义($P > 0.05$)。见表 3。

表 3 肩袖损伤不同治疗效果患者临床资料、MRI 参数比较

Table 3 Comparison of clinical data and MRI parameters of patients with different therapeutic effects for rotator cuff injury

组别	例数	性别(例数,%)		年龄 ($\bar{x} \pm s$, 岁)	体重指数 ($\bar{x} \pm s$)	糖尿病 (例数,%)	高血压 (例数,%)	冈上肌回缩距离 ($\bar{x} \pm s$, mm)
		男性	女性					
治疗有效	81	54(66.67)	27(33.33)	61.15 ± 6.21	22.42 ± 2.03	22(27.16)	33(40.74)	18.82 ± 3.12
治疗无效	21	15(71.43)	6(28.57)	65.54 ± 7.03	22.27 ± 1.96	5(23.81)	8(38.10)	24.41 ± 5.93
$\chi^2/t/Z$ 值		0.173		2.809	0.304	0.096	0.049	5.930
P 值		0.678		0.006	0.762	0.756	0.826	<0.001

组别	例数	肩胛下肌撕裂程度(例数,%)			冈下肌撕裂程度(例数,%)			肩袖损伤 MRI 分级(例数,%)		
		无撕裂	部分撕裂	完全撕裂	无撕裂	部分撕裂	撕裂	1 级	2 级	3 级
治疗有效	81	7(8.64)	53(65.43)	21(25.93)	9(11.11)	33(40.74)	39(48.15)	8(9.88)	42(51.85)	31(38.27)
治疗无效	21	0(0.00)	4(19.05)	17(80.95)	0(0.00)	9(42.86)	12(57.14)	2(9.52)	6(28.57)	13(61.90)
$\chi^2/t/Z$ 值		4.536			1.079			1.678		
P 值		<0.001			0.280			0.093		

2.4 多因素分析结果 以治疗效果(有效=0,无效=1)为因变量,以年龄(连续变量)、冈上肌回缩距离(连续变量)、肩胛下肌撕裂程度(无撕裂=0,部分撕裂=1,完全撕裂=2)为自变量,进行 Logistic 回归分析,结果显示:年龄、肩胛下肌撕裂程度是肩袖损伤患者非手术治疗效果的影响因素($P < 0.05$),见表 4。通过统计软件对收集的数据进行拟合分析

构建 Logistic 回归模型, $\text{logit}(\text{无效概率}) = \beta_0 + \beta_1 \times \text{年龄} + \beta_2 \times \text{肩胛下肌撕裂程度}$,其中 β_0 为常数项, β_1 和 β_2 分别为年龄和肩胛下肌撕裂程度的系数。该模型预测治疗无效的 ROC 曲线下面积为 0.813(95%CI:0.728~0.898), $P < 0.05$,敏感度和特异度分别为 88.00%和 64.50%,见图 1。

表4 多因素分析结果

Table 4 Results of multivariate analysis

因素	回归系数	标准误	Walds χ^2 值	P 值	OR 值	95% CI
年龄	0.663	0.192	11.924	<0.001	1.941	1.332~2.827
冈上肌回缩距离	0.281	0.315	0.796	0.625	1.324	0.714~2.456
肩胛下肌撕裂程度	1.112	0.278	16.000	<0.001	3.040	1.763~5.243

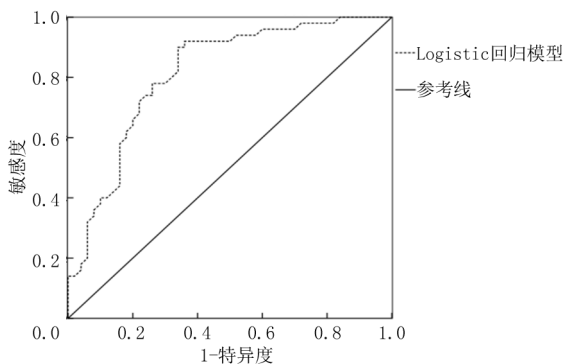


图1 ROC 曲线图

Figure 1 ROC curve

3 讨论

肩袖是由冈上肌、冈下肌、小圆肌和肩胛下肌共同组成的,维持着肱盂关节的稳定,同时提供肩关节活动所需的动力^[10]。肩袖损伤是成年人肩部关节痛和活动受限最常见的原因,它的常见病因主要包括外伤、慢性卡压等,是一个进行性的机械磨损过程,伴随着肌腱的退行性改变和撕裂^[11-12]。MRI检查对软组织具有较高的分辨力,对软组织病变具有较高的诊断和评估价值,目前有文献指出^[13],MRI对诊断肩袖损伤的敏感度高达80%,特异度高达90%。本文通过对我院肩袖损伤患者进行MRI检查,旨在探讨MRI在诊断肩袖损伤中的临床价值。本研究结果显示,MRI诊断肩袖损伤的敏感度、特异度、准确率、阳性预测值和阴性预测值分别为98.04%、94.44%、97.50%、99.01%和89.47%,与之前的研究结果一致^[14-16],进一步证实了MRI诊断肩袖损伤的价值。相同肌腱的显示在不同扫描方位上结果不尽相同,在某些特定方位上更具有显示优势,从而可以提高显示病变区域的敏感度和特异度,更清楚地判断损伤程度。肩袖部分撕裂时在MRI平扫上表现为灶性的,未贯穿全层但达冈上肌腱的关节面或滑囊面的高信号影。MRI检查提高了韧带和周围结构的对比度,从而提高了部分撕裂的诊断敏感度及特异度,这也是MRI的优点之一^[17]。

本研究结果显示,斜冠状位扫描冈下肌腱损伤和肩胛下肌腱损伤检出率明显低于轴位和斜矢状位扫描,斜矢状位扫描冈上肌腱损伤检出率明显低于

斜冠状位扫描,轴位和斜冠状位扫描小圆肌腱损伤检出率明显低于斜矢状位扫描。通过MRI信息可知矢状位较冠状位更容易观察到冈上肌肌腱的断裂情况。对这种改变的解釋包括黏液样变性、患者体位不当所致的伪影和部分容积效应等^[18]。

MRI检查是一种非放射性、非侵入性的检查方式,它可以多角度、多平面、多层次的对人体组织进行扫描显像,不需要注射造影剂,就可以在横断面、冠状面以及矢状面成像^[19]。在MRI上,轴位扫描用于显示肩关节的关节囊、关节孟唇、肱骨头、关节孟缘及肩胛下肌和冈下肌;冠状位斜位用来显示肩关节的冈上肌、肩峰下脂肪层和上、下关节孟唇;矢状斜位用来能够显示肩关节肩袖4块肌。评价肩关节最常用的是横断位和斜矢状位。横断位可用于显示肩关节孟唇及肩-肱肩距等。斜冠状位因能直接、清楚地显示肌腱撕裂和周围脂肪带的消失等征象而成为最重要的体位。不同的肌肉解剖位置导致其在MRI不同方位信号强弱不一^[20-21]。

本研究结果显示,治疗无效组年龄、冈上肌回缩距离明显高于治疗有效组($P < 0.05$);肩胛下肌撕裂程度明显重于治疗有效组,其完全撕裂比例为80.95%。Logistic回归分析显示:年龄、肩胛下肌撕裂程度是肩袖损伤患者非手术治疗效果的影响因素,此结果也与既往研究相一致^[22-23]。该模型预测治疗无效的ROC曲线下面积为0.813,敏感度和特异度分别为88.00%和64.50%。提示该模型具有一定的预测价值,但是对治疗无效者的预测尚缺乏特异度。DASH是上肢功能障碍量表,其分值越大,代表上肢活动障碍越大。退变是人体的自然现象,伴随着年龄的增长、组织结构的规律变化或消失,一些结缔肉芽组织发生变化,年龄越大的患者发生率高达60%以上,从而影响到非手术治疗的效果^[24]。创伤是肩袖损伤的主要原因,由于该部位缺乏血管,肩胛下肌肌腱比血管丰富区的肌腱更脆弱,撕裂程度越大,其退化程度越大,回缩距离越长,严重阻碍了血流的运输,导致预后较差。结合本次的研究结果,MRI对肩袖损伤具有一定的诊断价值,T1WI可以显示肌腱、肩袖肌的解剖结构,T2WI可以对病变部位、病变大小作出诊断,考虑到不同患者脂肪的影

响,依靠脂肪抑制序列也可以达到精确显示、准确诊断的目的^[25]。本研究存在以下不足:诊断肌腱损伤的金标准是肩关节镜,但是有报道关节镜检对腱内损伤仍不可避免漏诊,诊断结果与术者的经验有关,因此可能影响肩关节 MRI 的最终诊断价值评估。

综上所述,MRI 肩关节扫描可以清楚显示肩袖肌腱及其周围的组织结构,通过对不同部位的肩关节进行扫描,可以有效评估肩袖损伤的范围、程度,对临床提供有效的诊断信息。

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(本文编辑:赵丽洁)