前交叉韧带断裂合并半月板撕裂的解剖学影响因素分析

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摘　要　目的:分析前交叉韧带(anterior cruciate ligament,ACL)断裂合并半月板撕裂的解剖学影响因素。**方法:**纳入ACL断裂患者141例,从病历系统中提取患者的性别、年龄、损伤侧别、体质量指数、是否合并半月板撕裂等信息。在影像归档和通信系统中提取患者MRI,测量股骨髁间窝宽度指数、α角、β角、胫骨外侧平台后倾角和胫骨内侧平台后倾角等解剖学参数。根据半月板是否撕裂将纳入的患者分为合并半月板撕裂组和不合并半月板撕裂组。先对2组患者的相关信息进行单因素对比分析,然后对其中组间差异有统计学意义的因素进行多因素Logistic回归分析。采用受试者操作特征(receiver operating characteristic,ROC)曲线分析评价解剖学影响因素诊断ACL断裂合并半月板撕裂的价值。**结果:**合并半月板撕裂组76例,不合并半月板撕裂组65例。2组患者性别、股骨髁间窝宽度指数、α角、β角、胫骨内侧平台后倾角、胫骨外侧平台后倾角的比较,组间差异均有统计学意义($\chi^2=5.248$,$P=0.022$;0.247±0.032,0.273±0.024,$t=5.501$,$P=0.000$;46.70°±7.04°,50.73°±7.76°,$t=3.207$,$P=0.000$;41.48°±2.22°,38.30°±3.16°,$t=6.805$,$P=0.000$;6.85°±2.59°,5.61°±1.76°,$t=3.363$,$P=0.000$;8.04°±3.32°,5.34°±1.83°,$t=6.690$,$P=0.000$)。Logistic回归分析结果显示,股骨髁间窝宽度指数、β角、胫骨外侧平台后倾角是ACL断裂合并半月板撕裂的影响因素($\beta=-1.118$,$P=0.000$,$OR=3.060$;$\beta=0.530$,$P=0.000$,$OR=3.985$;$\beta=1.372$,$P=0.000$,$OR=3.944$)。ROC曲线分析结果显示,股骨髁间窝宽度指数、β角、胫骨外侧平台后倾角诊断ACL断裂合并半月板撕裂的临界值分别为0.250、38°、8°,敏感度分别为83.2%、88.8%、56.6%,特异度分别为60.8%、56.8%、88.6%,ROC曲线下面积分别为0.683($P=0.001$)、0.647($P=0.006$)、0.651($P=0.005$)。**结论:**股骨髁间窝宽度指数、β角、胫骨外侧平台后倾角是ACL断裂合并半月板撕裂的解剖学影响因素,应用股骨髁间窝宽度指数、β角、胫骨外侧平台后倾角诊断ACL断裂合并半月板撕裂具有一定的价值。

关键词　膝损伤;前交叉韧带损伤;半月板;解剖学;Logistic模型;ROC曲线

Analysis of anatomic factors influencing anterior cruciate ligament rupture combined with meniscus tears

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ABSTRACT　Objective: To analyze the anatomic factors influencing anterior cruciate ligament(ACL) rupture combined with meniscus tears(MTs). **Methods:** One hundred and forty-one patients with ACL rupture were enrolled in the study. The information about gender,age,injuried side,body mass index,whether combined with MTs was extracted from the electronic medical record system(EMRS). Moreover,the magnetic resonance imaging(MRI) of the included patients were extracted from the picture archiving and communication system(PACS),and the anatomical parameters including femoral intercondylar fossa(ICF) width index,angle α,angle β,lateral posterior tibial slope(PTS) and medial PTS were measured on the MRI images. The included patients were divided into MTs group and non-MTs group according to whether the MTs were present. The single-factor comparative analysis was performed on the relevant information of patients in the 2 groups,followed by multi-factor logistic regression analysis on the factors with statistically significant differences between the 2 groups. Furthermore,the values of anatomic factors in diagnosing ACL rupture combined with MTs were analyzed and evaluated by using receiver operating characteristic(ROC) curve. **Results:** One hundred and forty-one patients with ACL rupture were included in the final analysis,76 cases in MTs group and 65 cases in non-MTs group. The information including gender,femoral ICF width index,angle α,angle β,medial PTS and lateral PTS was compared between the 2 groups,and the results revealed that the differences were statistically significant($\chi^2=5.248$,$P=0.022$;0.247±0.032 vs 0.273±0.024,$t=5.501$,$P=0.000$;46.70±7.04 vs 50.73±7.76 degrees,$t=3.207$,$P=0.000$;41.48±2.22 vs 38.30±3.16 degrees,$t=6.805$,$P=0.000$;6.85±2.59 vs 5.61±1.76 degrees,$t=3.363$,$P=0.000$;8.04±3.32 vs 5.34±1.83 degrees,$t=6.690$,$P=0.000$). The results of logistic regression analysis showed that the femoral ICF width index,angle β and lateral PTS were the anatomic factors influencing ACL rupture combined with MTs($\beta=-1.118$,$P=0.000$,$OR=3.060$;$\beta=0.530$,$P=0.000$,$OR=$

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3.985;β = 1.372,P = 0.000,OR = 3.944). The results of ROC curve analysis showed that the diagnostic cut-off values of femoral ICF width index,angle β and lateral PTS in diagnosing ACL rupture combined with MTs were 0.250,38 degree and 8 degree;the sensitivity were 83.2%,88.8% and 56.6%;the specificities were 60.8%,56.8% and 88.6%;the areas under ROC curve were 0.683(P = 0.001),0.647(P = 0.006) and 0.651(P = 0.005) respectively. **Conclusion**:The femoral ICF width index,angle β and lateral PTS are the anatomic factors influencing ACL rupture combined with MTs,and they have a certain application values in diagnosis of ACL rupture combined with MTs.

Keywords　knee injuries;anterior cruciate ligament injuries;meniscus;anatomy;Logistic models;ROC curve

前交叉韧带(anterior cruciate ligament,ACL)损伤是临床上常见的膝关节运动损伤[1-3]。ACL 是维持膝关节稳定的重要解剖结构[4]。ACL 断裂会导致胫骨平台过度前移,进而可能引起半月板撕裂[5]。多项研究[6-10]表明,ACL 断裂合并半月板撕裂与膝关节的解剖学特征关系密切。明确 ACL 断裂合并半月板撕裂的解剖学影响因素,对于临床上诊断 ACL 断裂患者是否合并半月板撕裂具有重要意义。为此,我们分析了 ACL 断裂合并半月板撕裂的解剖学影响因素,现总结报告如下。

1　临床资料

1.1　一般资料　选取 2018 年 1 月至 2021 年 6 月在温州市中心医院住院治疗的 ACL 断裂患者的病例资料为研究对象。试验方案经温州市中心医院伦理委员会审查通过,伦理批件号:wz-zxyy-2021-05-03。

1.2　纳入标准　①确诊为急性初次 ACL 完全断裂;②合并或不合并半月板撕裂伤;③病例资料完整。

1.3　排除标准　①半月板撕裂由外伤直接导致者;②合并膝关节多发韧带损伤者;③合并先天性半月板畸形者;④合并严重下肢力线不良者;⑤有膝关节手术史者。

2　方　法

2.1　数据获取方法　从病历系统中提取纳入研究患者的性别、年龄、损伤侧别、体质量指数、是否合并半月板撕裂等信息。在影像归档和通信系统中提取患者过股骨内侧髁和外侧髁中部横断位 MRI,测量股骨髁间窝宽度指数和 α 角。股骨髁间窝宽度指数即股骨髁间窝最大宽度与股骨髁最大宽度的比值[图 1(1)];α 角是股骨髁间窝顶点与髁间窝最低端两点连线所成锐角[图 1(2)]。提取患者过胫骨平台中心的矢状位 MRI,测量 β 角。β 角是 Blumensaat 线与股骨纵轴线所成锐角[图 1(3)]。分别提取患者过胫骨外侧髁和胫骨内侧髁中心的矢状位 MRI,测量胫骨外侧平台后倾角和胫骨内侧平台后倾角。胫骨外侧平台后倾角为过胫骨外侧平台前后缘的连线与胫骨轴线的垂线所成锐角[图 1(4)],胫骨内侧平台后倾角为过胫骨内侧平台前后缘的连线与胫骨轴线的垂线所成锐角[图 1(5)]。

2.2　分组方法　根据半月板是否撕裂将纳入的患者分为合并半月板撕裂组和不合并半月板撕裂组。

2.3　数据统计方法　采用 SPSS24.0 统计软件对所得数据进行统计学分析。先对 2 组患者的相关信息进行单因素对比分析,然后对其中组间差异有统计学意义的因素进行多因素 Logistic 回归分析。2 组患者性别、损伤侧别的组间比较均采用 χ^2 检验,年龄、体质量指数、股骨髁间窝宽度指数、α 角、β 角、胫骨内侧平台后倾角及胫骨外侧平台后倾角的组间比较均采用 t 检验。采用受试者操作特征(receiver operating characteristic,ROC)曲线分析评价解剖学影响因素诊断 ACL 断裂合并半月板撕裂的价值。检验水准 $\alpha = 0.05$。

3　结　果

3.1　分组结果　共纳入 ACL 断裂患者 141 例,其中合并半月板撕裂组 76 例、不合并半月板撕裂组65 例。

3.2　ACL 断裂合并半月板撕裂影响因素的单因素分析结果　2 组患者性别、股骨髁间窝宽度指数、α 角、β 角、胫骨内侧平台后倾角、胫骨外侧平台后倾角的比较,组间差异均有统计学意义;2 组患者年龄、损伤侧别、体质量指数的比较,组间差异均无统计学意义(表 1)。

3.3　ACL 断裂合并半月板撕裂影响因素的多因素分析结果　将性别、股骨髁间窝宽度指数、α 角、β 角、胫骨内侧平台后倾角、胫骨外侧平台后倾角作为自变量,将是否合并半月板撕裂作为因变量进行 Logistic 回归分析。Logistic 回归分析结果显示,股骨髁间窝宽度指数、β 角、胫骨外侧平台后倾角是 ACL 断裂合并半月板撕裂的影响因素(表 2)。

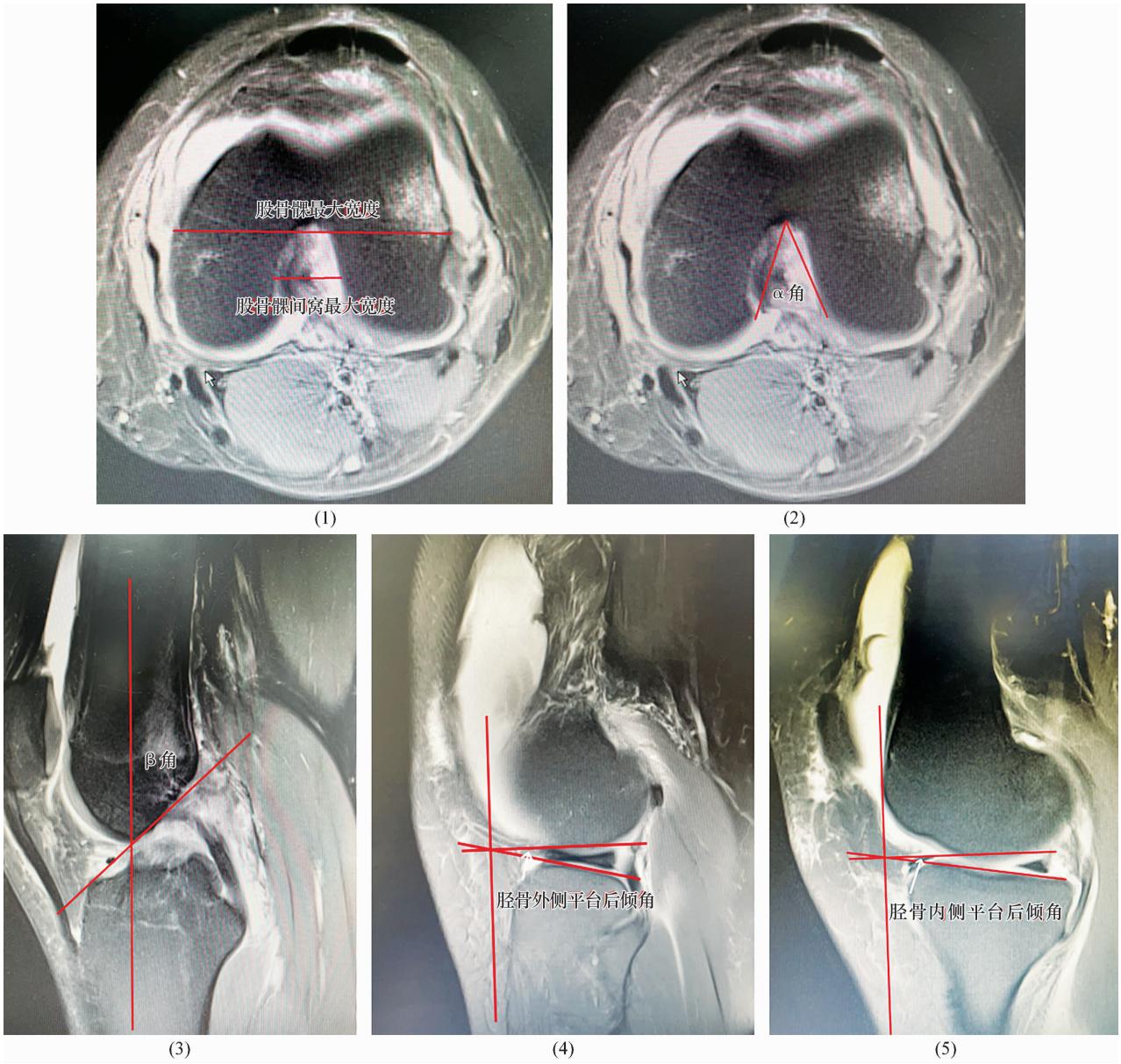

图 1　膝关节解剖学指标测量示意图

注：(1)(2)过股骨内侧髁和外侧髁横断位 MRI；(3)过胫骨平台中心矢状位 MRI；(4)过胫骨外侧平台中心矢状位 MRI；(5)过胫骨内侧平台中心矢状位 MRI。

表 1　前交叉韧带断裂合并半月板撕裂影响因素的单因素分析结果

组别	样本量/例	性别/例		年龄/（$\bar{x}\pm s$，岁）	损伤侧别/例		体质量指数/（$\bar{x}\pm s$，kg·m^{-2}）
		男	女		左侧	右侧	
合并半月板撕裂组	76	54	22	32.40±9.73	40	36	24.45±3.50
不合并半月板撕裂组	65	34	31	31.81±9.82	31	34	25.31±3.28
检验统计量		$\chi^2=5.248$		$t=1.458$	$\chi^2=0.342$		$t=0.868$
P 值		0.022		0.145	0.559		0.352

组别	股骨髁间窝宽度指数（$\bar{x}\pm s$）	α 角/（$\bar{x}\pm s$，°）	β 角/（$\bar{x}\pm s$，°）	胫骨内侧平台后倾角/（$\bar{x}\pm s$，°）	胫骨外侧平台后倾角/（$\bar{x}\pm s$，°）
合并半月板撕裂组	0.247±0.032	46.70±7.04	41.48±2.22	6.85±2.59	8.04±3.32
不合并半月板撕裂组	0.273±0.024	50.73±7.76	38.30±3.16	5.61±1.76	5.34±1.83
检验统计量	$t=5.501$	$t=3.207$	$t=6.805$	$t=3.363$	$t=6.690$
P 值	0.000	0.000	0.000	0.000	0.000

表 2　前交叉韧带断裂合并半月板撕裂影响因素的多因素 Logistic 回归分析结果

自变量	β	Wald	P	OR	95% CI	
					下限	上限
股骨髁间窝宽度指数	-1.118	5.251	0.000	3.060	2.156	8.010
β 角	0.530	0.186	0.000	3.985	1.320	1.786
胫骨外侧平台后倾角	1.372	5.438	0.000	3.944	1.202	1.684

注:变量赋值方式为合并半月板撕裂为 1、不合并半月板撕裂为 0,男性为 1、女性为 0。

3.4　解剖学影响因素诊断 ACL 断裂合并半月板撕裂的价值评价结果　ROC 曲线分析结果显示,股骨髁间窝宽度指数、β 角、胫骨外侧平台后倾角诊断 ACL 断裂合并半月板撕裂的临界值分别为 0.250、38°、8°,敏感度分别为 83.2%、88.8%、56.6%,特异度分别为 60.8%、56.8%、88.6%,ROC 曲线下面积分别为 0.683(P = 0.001)、0.647(P = 0.006)、0.651(P = 0.005)。见图 2。

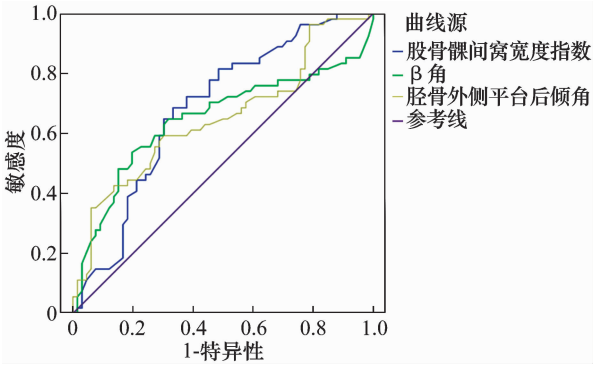

图 2　解剖学影响因素诊断前交叉韧带断裂合并半月板撕裂的受试者操作特征曲线图

4　讨　论

ACL 是膝关节最易损伤的韧带[11],ACL 损伤常合并半月板撕裂,进而导致膝关节疼痛、稳定性降低,并可能继发关节软骨损伤及骨关节炎[12-13]。多项研究[14-20]针对膝关节解剖学结构与 ACL 损伤合并半月板撕裂的相关性进行了分析,以期提高临床上诊断 ACL 损伤合并半月板撕裂的准确性。但研究结果尚存在一定差异。Stijak 等[21]研究发现,胫骨内侧平台后倾角与 ACL 损伤合并半月板撕裂存在相关性。Dare 等[22]研究发现,青少年胫骨外侧平台后倾角较大会增加 ACL 损伤合并半月板撕裂的风险。Wang 等[23]采用 Meta 分析系统评价了胫骨平台后倾角与 ACL 损伤合并半月板撕裂的关系,结果显示仅针对男性患者二者存在相关性。从生物力学角度分析,胫骨平台后倾角增大会增加胫骨向前移动的力,继而增大 ACL 损伤合并半月板撕裂发生的风险[24]。Alentorn-Geli 等[25]研究发现,股骨髁间窝宽度指数可能与 ACL 损伤合并半月板撕裂存在潜在关系。Zeng 等[26]研究发现,股骨髁间窝宽度指数较小会增加 ACL 损伤合并半月板撕裂发生的风险。Sturnick 等[11]研究发现,β 角与 ACL 损伤合并半月板撕裂有关,并认为 ACL 损伤合并半月板撕裂的影响因素是多方面的。我们针对股骨髁间窝宽度指数、α 角、β 角、胫骨内侧平台后倾角、胫骨外侧平台后倾角等膝关节解剖学指标与 ACL 损伤合并半月板撕裂的关系进行了分析,结果显示股骨髁间窝宽度指数、β 角、胫骨外侧平台后倾角是 ACL 断裂合并半月板撕裂的解剖学影响因素,应用股骨髁间窝宽度指数、β 角、胫骨外侧平台后倾角诊断 ACL 断裂合并半月板撕裂具有一定的价值。

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