·学术前沿:假体周围感染专题·

凝血相关指标在关节假体周围感染中的诊断价值

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摘　要:【目的】关节假体周围感染(PJI)是目前关节置换术后最严重的并发症。尽管许多标志物在PJI的诊断中取得了良好的效果,但早期的诊断仍然缺乏金标准。本研究旨在探讨凝血相关指标与全关节置换术(TJA)患者术后发生PJI的关系。【方法】我们进行了一项回顾性队列研究,选取在2011年1月至2022年1月期间接受了髋关节或膝关节置换术的总共2 517例患者(2 394例初次置换,87例无菌翻修,36例PJI)。我们应用多因素logistic回归分析,对比PJI组、初次置换和无菌翻修组之间凝血相关指标的差异。应用观察者操作特性曲线(ROC)和曲线下面积(AUC)来评估凝血相关指标在PJI中的诊断价值。【结果】本研究纳入的指标包括血浆纤维蛋白原(FBG),凝血酶原时间(PT),凝血酶时间(TT),活化部分凝血活酶时间(APTT),血小板(PLT),平均血小板体积(MPV),血小板分布宽度(PDW),血小板比容(PCT),PLT/MPV,PLT/PDW和PLT/PCT。与其他凝血相关指标相比,FGB水平升高与PJI发生风险密切相关。PJI组与初次置换组相比,FBG的最佳诊断界值为4.53 g/L,诊断敏感性为47.22%,特异性为93.07%;与翻修组比,FBG的最佳诊断界值为4.44 g/L,诊断敏感性为47.22%,特异性为95.40%。ROC曲线分析提示FBG具有中度诊断效能,表明其为PJI诊断的潜在标志物。【结论】FBG水平与PJI发生风险显著相关,可在临床中作为诊断PJI的重要指标。

关键词:关节假体周围感染;血浆纤维蛋白原;凝血相关指标;诊断
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Coagulation Factors for Diagnosis of Periprosthetic Joint Infection

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Abstract:【Objective】Periprosthetic joint infections (PJI) are currently the most calamitous complication after arthroplasty. Although achievements have been made in many markers for the diagnosis of PJI, the lack of a gold standard remains a great obstacle for early diagnosis. This study aimed to investigate the association between coagulation markers and the development of PJI in patients undergoing revision total joint arthroplasty (TJA).【Methods】We conducted a retrospective cohort study with a total of 2 517 patients who underwent hip or knee arthroplasties from January 2011 to January 2022 (2 394 with primary TJA, 87 with aseptic revision and 36 with PJI). We applied univariate analysis and multivariate logis-

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tic regression to analyze differences of coagulation factors between primary TJA and aseptic revision or PJI group. Receiver operating characteristic (ROC) curve and area under the curve (AUC) were used to measure the diagnostic value of coagulation factors in predicting PJI.【Results】Coagulation factors and their ratios including plasma fibrinogen (FBG), prothrombin time (PT), thrombin time (TT), activated partial thromboplastin time (APTT), platelet (PLT), mean platelet volume (MPV), platelet distribution width (PDW), plateletcrit (PCT), PLT / MPV, PLT / PDW and PLT / PCT were included in this study. High FGB level was strongly correlated with the risk of PJI compared to other coagulation factors. The optimal threshold value of FBG was 4.53 g/L with a sensitivity of 47.22%, a specificity of 93.07% (Primary TJA group vs. PJI group). Similarly, the optimal threshold value of FBG was 4.44 g/L with a sensitivity of 47.22%, a specificity of 95.40% between the other two groups (Aseptic revision group vs. PJI group). ROC curve analysis demonstrated moderate diagnostic performance of FBG (AUC value), indicating a potential to be a diagnostic marker for PJI.【Conclusions】FBG is significantly correlated with PJI and it can be used as a potential non-invasive marker for early detection. It may serve as a safe and cost-effective tool for assessing PJI in clinical work.

Key words: periprosthetic joint infection; plasma fibrinogen; coagulation-related indicators; diagnosis

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虽然关节假体周围感染(periprosthetic joint infection, PJI)的发生率比较低，但它的发生会给患者带来巨大的痛苦以及沉重的负担，并造成医疗资源的浪费[1-3]。约1%~2%的髋关节置换术后以及1%的膝关节置换术后患者被诊断为PJI[4-5]。PJI早期的诊断十分困难，但是尽早的诊断对后续的治疗十分重要[6]。目前已经有很多指标相继被用于诊断PJI。C反应蛋白(C-reactive protein, CRP)和血沉(erythrocyte sedimentation rate, ESR)是诊断PJI的常用指标，具有较高的敏感性和特异性。肌肉骨骼感染学会(MSIS)的最新指南也加入了一些新的标记物(如降钙素原和α-防御素)[7-8]。然而，如何快速准确地完成PJI的诊断仍然需要更多的探索[9-10]。凝血和炎症之间存在密切的相关性[11]，一些凝血相关指标(如纤维蛋白原、纤维蛋白降解产物、D-二聚体和血小板计数)与炎症的严重程度密切相关[12]。Chen等[13]认为，对于没有凝血障碍以及血栓形成的患者，D-二聚体对PJI的诊断价值高于CRP和ESR。D-二聚体水平升高不仅在感染中观察到，在炎症、癌症、出血和许多其他疾病中也观察到。FBG作为一种凝血相关指标，是许多炎症性疾病的关键调节因子[14-15]。之前有研究表明，FBG与PJI具有相关性[16-17]。然而，目前还没有明确的结论来证明FBG的诊断效果，还需要更多的案例和研究来验证。

1　材料与方法

1.1　研究设计与患者群体

我们采用回顾性单中心队列研究来调查凝血相关指标在PJI中的诊断价值。本研究经中山大学附属第一医院伦理委员会批准。所有研究方法均按照相关指南和规定进行。回顾性研究不需要签署知情同意书。从2011年1月至2022年1月，纳入髋关节或膝关节置换术行初次或翻修术的患者。最初，共纳入了2 768名患者，但其中251名被排除在外。排除标准如下：①术前诊断为类风湿性关节炎(RA)，强直性脊柱炎(AS)的患者；②患者在其他部位存在感染；③患者因脱位、假体周围骨折、假体断裂或手术部位感染而进行翻修手术；④严重肝功能不全的患者；⑤存在凝血功能异常、血液病或下肢静脉血栓形成的患者。最后，我们的研究纳入了2 394例初次翻修、87例无菌翻修和36例PJI患者。

1.2　诊断过程和治疗计划

我们对住院患者进行详细的问诊和体格检查，然后进行完整的术前评估。根据需要对患者进行术前检查，包括常规血液检查，心电图，心脏超声检查，X射线，CT和MRI检查，MSIS标准用于辅助PJI

诊断,PJI患者感染相关血清学标志物水平显著升高。绝大多数确诊为PJI的患者进行手术治疗,我们在术中从不同部位取组织进行微生物培养,为了最大限度地消除感染,稀释的聚维酮碘+双氧水冲洗方案在术中进行3次,术中和术后连续使用静脉注射第二代头孢菌素,然后根据术后微生物培养结果调整抗生素治疗方案。手术均由关节置换术经验丰富的五位外科医生之一进行,所有膝关节手术均采用髌骨内侧入路,髋关节手术均采用后外侧入路。我们应用肝素或其他抗凝药物预防术后深静脉血栓形成。常规进行感染相关指标的术后定期监测。

1.3 数据收集和实验室检查

我们回顾性分析了患者的临床资料,收集了患者的性别,年龄,血压和血糖等信息。纤维蛋白原(fibrinogen, FBG)、凝血酶原时间(prothrombin time, PT)、凝血酶时间(thrombin, time TT)、活化部分凝血活酶时间(activated partial thromboplastin time, APTT)、血小板(platelet, PLT)、平均血小板体积(mean platelet volume, MPV)、血小板分布宽度(platelet distribution width, PDW)和血小板容积比(plateletcrit, PCT)等指标在手术前完成测定。

1.4 统计分析

数据分析处理采用SPSS 25.0统计软件,连续变量均表示为中位数四分位数M(P_{25}, P_{75})。使用单因素方差分析计算年龄差异。使用卡方检验计算患者n(%)差异。对于年龄,手术部位,性别,血压和血糖等指标,应用多变量logisitic回归校正P值。使用ROC曲线和AUC值来测量诊断值。Youden指数用来确定最佳诊断界值。P<0.05为差异有统计学意义。

2 结 果

2.1 患者一般情况

接受关节置换的患者被分为3组,包括初次置换组(n=2 394),无菌翻修组(n=87)和PJI组(n=36)。3组间年龄,血糖,血压差异无统计学意义(P>0.05)。接受初次置换的患者女性居多(P<0.05)。髋关节因无菌性松动导致翻修的发生率高于膝关节(P<0.05;表1)。

2.2 凝血相关指标的比较

分析比较PJI组和初次置换、无菌翻修组之间凝血相关指标的差异,并采用Bonferroni法进行矫正。组间FBG(P<0.001),PT(P<0.008),APTT(P=0.015),PDW(P=0.001)和PLT/PDW(P=0.018),差异具统计学意义。在上述指标中,FGB的变化最为明显。此外,使用多变量logisitic回归调整人口统计学和临床协变量后,3组间FGB仍上升最为明显(均P<0.001),并且许多凝血相关指标仍然具有统计学意义(表2-1,2-2,2-3,图1)。

2.3 凝血相关指标对PJI的诊断效能

ROC曲线和AUC用于评估试验的诊断价值,PJI组与初次置换组相比,FBG, PT, APTT, PLT, PDW, PLT/MPV和PLT/PDW的AUC(95%CI)值分别为[0.74(0.718,0.753), P<0.001],[0.69(0.673, 0.710), P<0.001],[0.63(0.615,0.654), P=0.004], [0.59 (0.572, 0.612) (P=0.090)], [0.68 (0.659, 0.696), P<0.001],[0.60(0.579,0.618), P=0.064]和[0.63(0.615,0.654), P=0.008];PJI组与无菌翻修组相比,FBG, PLT, PDW, PLT/MPV和PLT/PDW的AUC(95%CI)值分别为[0.76(0.673,0.831), P< 0.001], [0.61 (0.516, 0.694), P=0.077], [0.69 (0.601,0.771), P=0.000],[0.62(0.529,0.707), P= 0.047]和[0.65 (0.559, 0.734), P=0.009]。根据Youden指数确定最佳诊断界值。PJI组与初次置换组相比,FBG的最佳诊断界值为4.53 g/L,敏感性为47.22%,特异性为93.07%;PJI组与无菌翻修组相比,FBG的最佳诊断界值显示为4.44 g/L,敏感性为47.22%,特异性为95.40%。所有其他指标的特异性均低于FBG(AUC<0.7)。与其他凝血相关指标相比,FBG的诊断效能被认为是相对可靠的(表3,图2)。

3 讨 论

PJI的早期诊断对随后的治疗具有重要意义,对于PJI诊断标志物的研究越来越深入[18]。虽然近

表1　关节置换术后患者一般特征

Table 1　The characteristics of patients who underwent total joint arthroplasty [n, M (P_{25}, P_{75}), n(%)]

Group and Variable	Primary TJA	Aseptic Revision	PJI	H/χ^2	P
No. of patients	2 394	87	36		
Age/year	65.0(57.0, 72.0)	65.0(52.0, 72.0)	65.5(58.0, 70.0)	0.651[1)]	0.379
Sex				11.499[2)]	0.003
Female	1 686 (70.4%)	48 (55.2%)	21 (58.3%)		
Male	708 (29.6%)	39 (44.8%)	15 (41.7%)		
Joint				56.803[2)]	< 0.001
Hip	1 090 (45.5%)	75 (86.2%)	20 (55.6%)		
Knee	1 304 (54.5%)	12 (13.8%)	16 (44.4%)		
Diabetes Mellitus				0.232[2)]	0.890
Diabetic	280 (11.7%)	11 (12.6%)	5 (13.9%)		
Nondiabetic	2 114 (88.3%)	76 (87.4%)	31 (86.1%)		
Blood pressure				5.331[2)]	0.070
Hypertension	846 (35.3%)	21 (24.1%)	15 (41.7%)		
Nonhypertension	1 548 (64.7%)	66 (75.9%)	21 (58.3%)		

[1)] Data are presented as median (interquartile range) and calculated by the Kruskal Wallis H test. [2)] Data are presented as the number (percentage) of patients and calculated by the chi-square test. $P < 0.05$ was regarded as statistically significant. TJA: total joint arthroplasty; PJI: periprosthetic joint infection.

表 2-1　初次置换、无菌翻修和PJI组之间凝血标志物的比较

Table 2-1　The comparison of coagulation biomarkers between patients with primary TJA, aseptic and septic revision

[M (P_{25}, P_{75})]

Coagulation Biomarkers	Primary TJA	Aseptic Revision	PJI	H	P
Fbg/(g/L)	2.98(2.57, 3.52)	2.95(2.52, 3.45)	3.97(3.02, 4.72)	24.742	< 0.001
PT/s	11.40(11.00, 12.00)	11.50(11.00, 12.20)	12.00(11.53, 12.70)	17.078	0.008
TT/s	17.60(16.90, 18.40)	17.60(16.70, 18.16)	17.20(16.30, 18.38)	3.261	0.196
APTT/s	27.00(24.90, 29.50)	27.10(25.00, 29.36)	28.85(25.98, 31.58)	8.350	0.015
PLT/($\times10^9$/L)	232.0(196.0, 275.0)	228.5(184.0, 263.0)	248.0(210.8, 346.6)	4.066	0.131
MPV/fL	10.00(9.40, 10.60)	10.00(9.47, 10.60)	9.60(9.33 , 10.10)	5.162	0.076
PDW/fL	11.80(10.70, 13.60)	12.00(10.80, 13.19)	10.85(9.93, 11.78)	13.599	0.001
PCT/%	0.23(0.20, 0.27)	0.23(0.20, 0.26)	0.24(0.22, 0.34)	2.559	0.278
PLT/MPV	23.51(18.98, 28.63)	23.12(19.22, 25.63)	25.30(21.05, 36.92)	4.659	0.097
PLT/PDW	19.62(14.93, 24.58)	19.51(14.64, 22.88)	22.26(16.99, 33.38)	7.999	0.018
PLT/PCT	1 000.00 (938.10,1 063.17)	997.06 (925.00,1 047.49)	1 045.65 (998.20,1 082.54)	6.399	0.041

Data are presented as median (interquartile range) and calculated by the Kruskal Wallis H test. $P < 0.05$ was regarded as statistically significant. TJA: total joint arthroplasty; PJI: periprosthetic joint infection; CI: confidence interval; Fbg: fibrinogen; PT: prothrombin time; TT: thrombin time; APTT: activated partial thromboplastin time; PLT: platelet; MPV: mean platelet volume; PDW: platelet distribution width; PCT: plateletcrit.

表 2-2 初次置换和PJI组之间凝血标志物的多因素logistic回归分析

Table 2-2 The multivariate logistic regression analysis of coagulation biomarkers between patients with primary TJA and septic revision

Variable	b	S_b	Wald χ^2	Adjusted P	OR	OR 95%CI
Constant	−4.197	0.618	624.799	< 0.001	–	–
Fbg/(g/L)	0.628	0.114	30.398	< 0.001	1.873	(1.499,2.342)
PT/s	0.435	0.122	12.723	< 0.001	1.545	(1.216,1.961)
TT/s				0.062	–	–
APTT/s	0.123	0.037	11.193	0.001	1.131	(1.052,1.215)
PLT/($\times10^9$/L)	0.005	0.002	6.694	0.010	1.005	(1.001,1.009)
MPV/fL				0.138	–	–
PDW/fL	−0.305	0.098	9.597	0.002	0.737	(0.608,0.894)
PCT/%				0.061	–	–
PLT/MPV	0.046	0.017	7.316	0.007	1.047	(1.013,1.082)
PLT/PDW	0.060	0.016	13.993	< 0.001	1.062	(1.029,1.095)
PLT/PCT				0.167	–	–

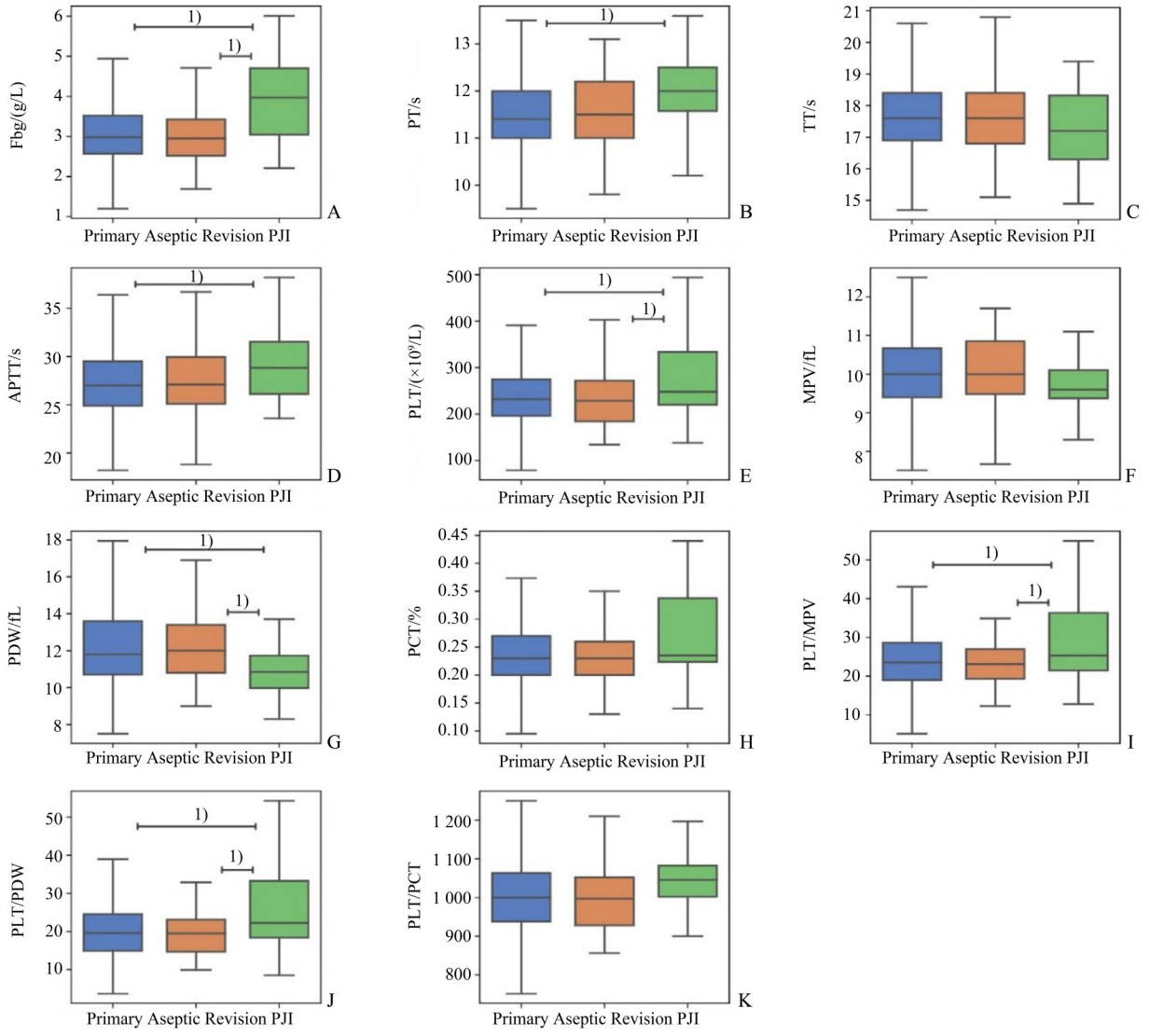
The adjusted P value was assessed by the multivariate logistic regression (forward likelihood ratio method) regarding age, operative joint, sex, hypertension, and diabetic status. $P < 0.05$ was regarded as statistically significant. TJA: total joint arthroplasty; PJI: periprosthetic joint infection; CI: confidence interval; Fbg: fibrinogen; PT: prothrombin time; TT: thrombin time; APTT: activated partial thromboplastin time; PLT: platelet; MPV: mean platelet volume; PDW: platelet distribution width; PCT: plateletcrit.

表 2-3 无菌翻修和PJI组之间凝血标志物的多因素logistic回归分析

Table 2-3 The multivariate logistic regression analysis of coagulation biomarkers between patients with aseptic and septic revision

Variable	b	S_b	Wald χ^2	Adjusted P	OR	OR 95%CI
Constant	−0.882	0.198	19.826	< 0.001	–	–
Fbg/(g/L)	1.171	0.279	17.638	< 0.001	3.225	(1.867,5.571)
PT/s				0.204	–	–
TT/s				0.727	–	–
APTT/s				0.246	–	–
PLT/($\times10^9$/L)	0.006	0.003	4.303	0.038	1.006	(1.000,1.013)
MPV/fL				0.190	–	–
PDW/fL	−0.364	0.135	7.287	0.007	0.695	(0.533,0.905)
PCT/%				0.110	–	–
PLT/MPV	0.057	0.026	4.821	0.028	1.059	(1.006,1.114)
PLT/PDW	0.078	0.026	9.060	0.003	1.081	(1.028,1.138)
PLT/PCT				0.173	–	–

The adjusted P value was assessed by the multivariate logistic regression (forward likelihood ratio method) regarding age, operative joint, sex, hypertension, and diabetic status. $P < 0.05$ was regarded as statistically significant. TJA: total joint arthroplasty; PJI: periprosthetic joint infection; CI: confidence interval; Fbg: fibrinogen; PT: prothrombin time; TT: thrombin time; APTT: activated partial thromboplastin time; PLT: platelet; MPV: mean platelet volume; PDW: platelet distribution width; PCT: plateletcrit.



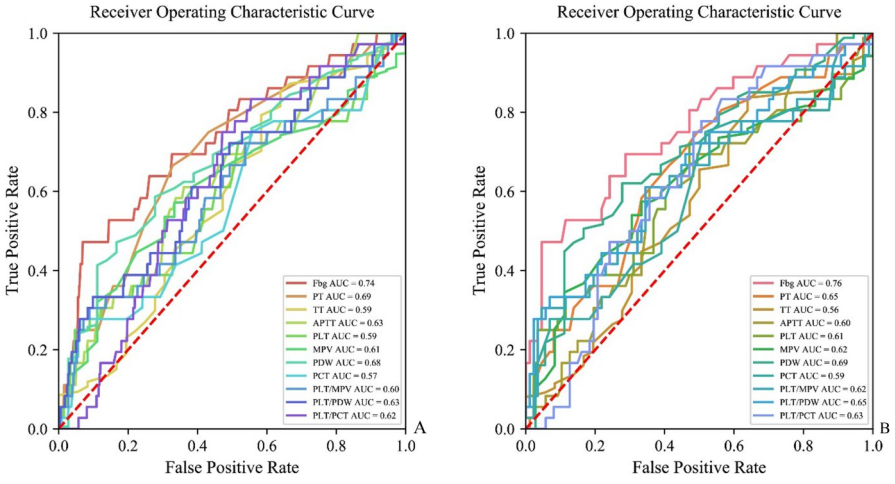
The asterisks indicate a significant difference between groups. The *P* values were calculated by the Kruskal Wallis *H* test and adjusted by the multivariate logistic regression. 1) $P < 0.05$. Solid lines within the box indicate median, top and bottom lines of box equal interquartile range (IQR), and whiskers indicate values within 1.5 IQR of the top or bottom of the box.

图1　初次置换、无菌翻修与PJI之间感染标记物的比较

Fig. 1　The comparison of coagulation biomarkers between patients with primary TJA, aseptic and PJI

年来一些新的诊断标志物相继被发现，但很少被MSIS认可。血清标志物检测是PJI特别简便且经济的诊断方法。虽然近些年也有一些新技术应用于PJI的诊断，如质谱、新一代测序，但其效能仍需进一步讨论和验证[19-23]。作为诊断标志物，凝血相关指标水平可能在感染状态下升高。

许多传统标志物已被证明对PJI的诊断有重要意义。C反应蛋白（CRP）和血沉（ESR）是最广泛使用的用于诊断PJI的标志物[24]。Huerfano等[25]对文献进行了荟萃分析，得出的结论为ESR的敏感性和特异性分别为86%和86.9%，CRP的敏感性和特异性分别为72.3%和78.6%。以上二者的结合可以将敏感性提高到100%[26]。近年来，有人提出D-二聚体也可用于PJI诊断[27]。FBG作为凝血因子有可能成为PJI的诊断标志物，尽管目前MSIS尚未将其纳入。凝血系统最主要的功能是止血，但它也与感染密切相关[28]。细菌引起的中性粒细胞活化可促进感染状态下的凝血[29]。凝血相关指标能在很大程



Fbg: fibrinogen; PT: prothrombin time; TT: thrombin time; APTT: activated partial thromboplastin time; PLT: platelet; MPV: mean platelet volume; PDW: platelet distribution width; PCT: plateletcrit; AUC: area under the curve.

图2 凝血标志物诊断假体周围感染的ROC曲线

Fig. 2 The ROC curves of coagulation biomarkers in the diagnosis of periprosthetic joint infection

表3 凝血标志物预测PJI的诊断效能

Table 3 The diagnostic performances of coagualtion biomarkers in predicting PJI

Items	Fbg	PT	TT	APTT	PLT	MPV	PDW	PCT	PLT/MPV	PLT/PDW	PLT/PCT
Primary vs. PJI											
P	<0.001	<0.001	0.108	0.004	0.090	0.006	<0.001	0.165	0.064	0.008	0.003
AUC	0.74	0.69	0.59	0.63	0.59	0.61	0.68	0.57	0.60	0.63	0.62
Threshold	4.53	11.75	16.40	28.10	230.00	9.85	11.40	0.33	34.72	30.10	985.48
Sensitivity/%	47.22	66.67	36.11	61.11	72.22	66.67	72.22	27.78	30.56	33.33	83.33
Specificity/%	93.07	67.08	85.30	63.91	48.29	57.18	58.65	93.82	91.10	90.14	44.57
+LR	6.81	2.03	2.46	1.69	1.40	1.56	1.75	4.49	3.43	3.38	1.50
−LR	0.57	0.50	0.75	0.61	0.58	0.58	0.47	0.77	0.76	0.74	0.37
PPV/%	9.3	3.0	3.6	2.5	2.1	2.3	2.6	6.3	4.9	4.8	2.2
NPV/%	99.2	99.3	98.9	99.1	99.1	99.1	99.3	98.9	98.9	98.9	99.4
Aseptic vs. PJI											
P	<0.001	0.006	0.280	0.081	0.077	0.028	0.000	0.112	0.047	0.009	0.014
AUC	0.76	0.65	0.56	0.60	0.61	0.62	0.69	0.59	0.62	0.65	0.63
Threshold	4.44	11.50	16.40	27.90	230.00	9.85	11.40	0.22	34.68	21.47	992.30
Sensitivity/%	47.22	75.00	36.11	61.11	72.22	66.67	72.22	75.00	30.56	61.11	77.78
Specificity/%	95.40	50.57	83.91	64.37	52.87	57.47	62.07	48.28	95.40	65.52	49.43
+LR	10.27	1.52	2.24	1.72	1.53	1.57	1.90	1.45	6.65	1.77	1.54
−LR	0.55	0.49	0.76	0.60	0.53	0.58	0.45	0.52	0.73	0.59	0.45
PPV/%	81.0	38.6	48.1	41.5	38.8	39.3	44.1	37.5	73.3	42.3	38.9
NPV/%	81.4	83.0	76.0	80.0	82.1	80.6	84.4	82.4	76.9	80.3	84.3

PJI: periprosthetic joint infection; Fbg: fibrinogen; PT: prothrombin time; TT: thrombin time; APTT: activated partial thromboplastin time; PLT: platelet; MPV: mean platelet volume; PDW: platelet distribution width; PCT: plateletcrit; AUC: area under the curve; PPV: positive predictive value; NPV: negative predictive value; +LR: positive likelihood ratio; −LR: negative likelihood ratio.

度上反映凝血功能。多个凝血标志物的水平，如PT、APTT、D-二聚体、FBG，已被证明可在感染状态下升高[30]。这些指标很少被用作PJI的诊断标志物，但我们认为FBG、PT、APTT等指标在感染的影响下会发生改变。其中FBG是重要的凝血相关指标之一[31]。它是一种主要由肝细胞合成和分泌的糖蛋白[32]。机械损伤、感染或免疫紊乱可导致凝血相关指标升高[33]。此外，FBG还是COPD和风湿性多肌痛的可靠标志物[34-35]。Pan的研究表明，FBG对PJI有很高的诊断价值，甚至优于血浆D-二聚体[36]。Qiao等[12]研究了凝血相关指标对PJI的诊断效果，并探讨了它们是否能指导再植入的时机。他们认为血小板计数（PC）、PC/MPV比值（PVR）和FBG对PJI的诊断具有较高的敏感性和特异性。在我们的研究中，增加了一个具有相当大样本量的初次置换组，以探究FBG与其他凝血相关指标诊断PJI的准确性。在所有凝血相关指标中，FBG的诊断效能最高。PJI组与初次置换组相比AUC为0.74（0.718，0.753），敏感性为47.22%，特异性为93.07%；PJI组与无菌翻修组相比，AUC为0.76（0.673，0.831），敏感性为47.22%，特异性为95.40%。

与过去的研究相比，我们的研究结果表明FBG在诊断PJI方面具有高特异性，但敏感性较低。原因如下：①我们的研究中有一些低毒力PJI患者，他们FBG水平并没有显著变化；②我们制定了严格的纳入标准，排除了由于其他炎症性疾病导致FBG升高的病例。我们认为FBG不是PJI早期诊断最敏感的标志物，但是对于明确诊断极为重要。本研究的内容不仅限于FBG，还扩展到其它凝血相关指标。在我们的结果中，PLT/PCT值具有较高的敏感性，但特异度较低，PT的特异性低于FBG。在详细对比所有凝血相关指标的结果后，我们发现FBG是诊断PJI最可靠的指标。

在我们的研究中，纳入了大量样本来探讨FBG对PJI患者的诊断效能。此外，我们将病例分为三组，分别将PJI与初次翻修和无菌翻修组进行比较。然而，这项研究也有一些局限性：①本研究收集的患者均为我院关节外科患者，存在地域和种族限制；②FGB可能无法检测到最高值；③本文是一项回顾性研究，数据来源于疾病记录和检查结果，患者信息的收集可能存在一些偏差；④因为患病率低的缘故，无菌翻修组和PJI组的患者数量相对较少，需要进行大规模的多中心研究来进一步验证当前的结论；⑤由于无菌翻修组和PJI组的患者较少，髋关节和膝关节并未区分成亚组进行分析。

我们对绝大多数凝血相关指标进行了统计分析。在所有凝血相关指标中，FBG仍然是最可靠的PJI诊断标志物。未来对于PJI的诊断标志物仍需要更多的大规模和多中心研究来进一步验证。

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