Clinical characteristics and risk factors of Fulminant Mycoplasma pneumoniae pneumonia in children

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Research article

Keywords: Fulminant Mycoplasma pneumoniae pneumonia, clinical characteristics, risk factors

Posted Date: February 8th, 2020

DOI: https://doi.org/10.21203/rs.2.22954/v1

Version of Record: A version of this preprint was published on July 22nd, 2020. See the published version at https://doi.org/10.1186/s12879-020-05270-6.

Abstract

BACKGROUND: Analyze the clinical characteristics of Fulminant Mycoplasma pneumoniae pneumonia (FMPP), and explore the related factors predicting FMPP.

METHODS: A retrospective case-control study was performed on 345 children with Mycoplasma pneumoniae pneumonia (MPP) hospitalized in our Hospital from January 2017 to June 2019. The clinical features, laboratory data and radiological findings were compared between the FMPP group, refractory Mycoplasma pneumoniae pneumonia (RMPP)group and general Mycoplasma pneumoniae pneumonia (GMPP) group.

RESULTS: FMPP patients (n=69) had more severe presentations, higher incidence of extra-pulmonary complications and more serious radiological findings(P<0.05). And the days of fever and the days in hospital were longer, and FMPP patients also need more complicated treatments(P<0.05). Meanwhile, the levels of white blood cell count(WBC) ,C-reactive protein(CRP), lactic dehydrogenase (LDH), interleukin (IL)-6,ferritin, D-dimer, fibrinogen(FG),alanine aminotransferase(ALT) and the percentage of neutrophils in the FMPP group were significantly higher than those in the RMPP group and the GMPP group (both P<0.05). In ROC curve analysis, the percentage of neutrophils, WBC, CRP, LDH, IL-6, ferritin, D-dimer and ALT were contributed to identify FMPP patients. Multivariate logistic regression analysis showed that ferritin>174.15 ng/mL, IL-6>25.475pg/ml and pleural effusion had significant predictive effects on the early diagnosis of FMPP (P<0.01).

Conclusion: FMPP patients presented more serious clinical manifestations. Ferritin>174.15 ng/mL, IL-6>25.475pg/ml and pleural effusion were high risk factors for FMPP.

Background:

Mycoplasma pneumoniae (MP) is one of the most prevalent pathogens causing community-acquired pneumonia (CAP) in children. Mycoplasma pneumoniae pneumonia(MPP) accounts for 10%-40% of CAP in hospitalized children, and mainly occurs in 5 years children or older[1, 2]

Although MPP is usually considered as a self-limited disease, sometimes it may cause serious intrapulmonary and extrapulmonary complications, such as atelectasis, pleural effusion, chest pain, dyspnea and even endanger the lives of patients[3]. In generally, macrolides are the first-choice antibiotics for MP infections. Some patient treated regularly with macrolides for 7 days or longer and the clinical and radiological deterioration, which can be defined as refractory Mycoplasma pneumoniae pneumonia (RMPP)[4]. Some cases even complicated with hypoxemia during the course of the disease, and the radiological imaging often manifested as diffuse consolidation of the lungs and pulmonary interstitial damage, which were called fulminant Mycoplasma pneumoniae pneumonia (FMPP) in some literatures[5]. Up to now, there is little research on FMPP, and its specific definition is not clear. But

hypoxemia is a risk factor affecting the prognosis of patients. Therefore, it is vital for clinicians to recognize FMPP earlier and grasp the appropriate opportunity for reasonable therapy.

In order to explore the related factors predicting FMPP earlier, provide appropriate treatments and reduce complications, we retrospectively analyzed the cases of MPP hospitalized in our hospital between January 2017 and June 2019, then compared the differences of clinical features, laboratory data and radiological findings, between the FMPP、RMPP and general Mycoplasma pneumoniae pneumonia(GMPP).

Methods

Patient Selection

Clinical information

69 patients with FMPP were admitted to the Respiratory Department of Tianjin Children's Hospital from January 2017 to June 2019. We also randomly selected 86 patients in the RMPP group and 190 patients in the GMPP group from the same period. All cases met the diagnostic criteria.
Diagnostic criteria: All patients had clinical evidence of pneumonia on admission such as a fever, cough and pneumonic infiltrations in the chest radiograph. MP infection was based on a positive result of serological tests (MP-IgM antibody titer ≥ 1:160) and the positive results for MP polymerase chain reaction (PCR) tests of nasopharyngeal secretions. The diagnosis of RMPP was based on clinical and radiological deterioration after azithromycin treatment for 7 days or longer [4]. The diagnosis of FMPP was based on apparent presence of MP infection with hypoxia(on room air, arterial oxygen saturation ≦ 92% or PaO2 ≦ 60 mmHg)[5].

The inclusion criteria

(1) met the diagnostic criteria of FMPP, RMPP and GMPP;(2) the age was less than 15 years old.

The exclusion criteria

(1) who had other respiratory pathogen infections and tuberculosis. (2) who had basic diseases such as asthma, chronic cardiopulmonary disease, rheumatism and immune deficiency. (3) who had previous history of hypoxemia. (4) who had used glucocorticoid before admission.

Data collection

Hospitalization demographic, clinical information, laboratory data and radiological findings of all children included in the study were collected retrospectively. Peripheral blood samples were obtained on admission for the determination of complete blood count, C-reactive protein (CRP), lactic dehydrogenase (LDH), procalcitonin (PCT), interleukin (IL)-6, lactic acid, ferritin(Fer), D-dimer, fibrinogen (Fg), alanine aminotransferase (ALT), aspartate aminotransferase (AST) and specific antibody to MP. Nasopharyngeal

aspirate were collected for MP-PCR detection within 24 hours of hospitalization. Chest CT examination was performed during hospitalization.

Observation indexes

clinical features (sex, age, duration of fever, peak fever, dyspnea, complications, etc.), laboratory data, radiological findings, treatment and hospitalization time.

Ethics

The study was approved by the ethics committee of the Tianjin Children's Hospital. And the data from patients were analyzed anonymously.

Data analysis

SPSS 22.0 was used for statistical analysis. The normal distribution data was represented by mean ± SD ($\bar{x} \pm s$). One-way ANOVA was used for comparison between groups. The LSD-t test was used for comparison within the group. The skewed distribution data were expressed as median (P25, P75), which comparisons were made by the Mann-Whitney U-test. And Chi-squared tests were used to compare categorical data. Receiver operating characteristic (ROC) curves were operated to evaluate candidate markers related to FMPP, and logistic regression analysis was performed to select variables associated with FMPP. The difference was considered statistically significant at $P < 0.05$.

Results:

Basic information of patients

194 male and 151 female patients with a median age of 8 years (range 4–6 years) were included in this study. There were 69 cases in FMPP group (34 men; 35 women),86 cases in RMPP group (48 men; 38women) and 190 cases in GMPP group (112 men; 78 women).Median age was 6 years (range 4–8) in FMPP group,6 years (range 4–8) in RMPP group and 6 years (range 4–7) in GMPP. There was no statistically significant difference in age and gender between three groups.

Clinical Characteristics Of Patients

All patients presented cough, and 350(98.87%) patients had fever. In addition, FMPP group had higher fever (39.1–41℃) than the other two groups(both p□0.05). We further compared the other symptoms. The incidence of rash, liver function damage ,chest pain, toxic encephalopathy, embolism, dyspnea, plastic bronchitis were significantly higher in the FMPP patients than those in the other two groups($p<0.05$, $p<0.05$, $p<0.01$,$p<0.01$, $p<0.01$,$p<0.01$,$p<0.01$ respectively).

Table 1

Clinical characteristic of FMPP、RMPP and GMPP patients

Clinical information	FMPP(n = 69)	RMPP(n = 86)	GMPP(n = 190)	P-value
Sex(male/female)	34/35	48/38	112/78	0.381
Age, years	6(4–8)	6(4–8)	6(4–7)	0.125
Clinical presentation n(%)				
Fever	69(100%)	86(100%)	186(97.89%)	1.000
				0.000
37.5–38℃	0(0%)	0(0%)	10(5.38%)	
38.1–39℃	6(8.69%)	20(23.25%)	53(28.49%)	
39.1–41℃	61(88.41%)	64(74.42%)	122(65.59%)	
≥41℃	2(2.90%)	2(2.33%)	1(0.54%)	
Cough	69(100%)	86(100%)	190(100%)	1.000
Chest pain	18(26.09%)	3(3.49%)	2(1.05%)	0.000
Rash	10(14.49%)	3(3.49%)	14(7.37%)	0.043
Embolism	7(10.14%)	0(0%)	0(0%)	0.000
Wheezing	8(11.59%)	10(11.63%)	30(15.79%)	0.533
Dyspnea	69(100%)	2(2.32%)	0(0%)	0.000
Liver function damage	13(18.84%)	5(5.81%)	16(8.42%)	0.023
Toxic encephalopathy	9(13.04%)	2(2.32%)	0(0%)	0.000
Plastic bronchitis	36(52.17%)	16(18.60%)	2(1.05%)	0.000
Length of fever, days	12(9–14)	10(8–12)	6(8–10)	0.000
Length of stay, days	12(9–15)	9(8–10)	6(5–7)	0.000
Management				
Azithromycin for the first few days of fever	6(4–8)	6(5–8)	6(4–8)	0.057
Using glucocorticoids	69(100%)	58(84.06%)	78(41.05%)	0.000
Glucocorticoids for the first few days of fever	10(8–12)	9(7–10)	9(7–11)	0.020

Clinical information	FMPP(n = 69)	RMPP(n = 86)	GMPP(n = 190)	P-value
using gamma immunoglobulin	34(49.27%)	0(0%)	0(0%)	0.000
using fiberoptic bronchoscope	58(84.06%)	61(70.93%)	82(43.16%)	0.000
1 time	18(26.09%)	40(46.51%)	73(38.42%)	
2 times	30(43.48%)	20(23.25%)	9(4.74%)	
3 times	10(14.49%)	1(1.16%)	0(0%)	
Using oxygen-therapy	69(100%)	2(2.32%)	0(0%)	0.000
Data are presented as number(percentage), median (25th-75th percentile)				

Laboratory And Imagine Features Of Patients

Laboratory data and radiological findings in FMPP, RMPP and GMPP patients were summarized in Tables 2 and 3.In terms of Laboratory data, the mean levels of white blood cell count(WBC) ,percentage of peripheral neutrophils, CRP in FMPP patients were significantly higher than that in other groups(p all<0.01). We also found that obviously higher levels of IL-6,ALT, and ferritin in the FMPP group compared to the others (p all<0.01). And the level of fibrinogen(Fg) was lower in FMPP (p all<0.05).As for LDH and D-dimer, there were statistically differences only in FMPP and GMPP groups(p<0.01), In contrast, PCT, lactic acid and AST showed no difference among the three groups (p>0.05).

In addition to laboratory data, radiological findings were more serious in patients with FMPP. The proportion of pulmonary consolidation among FMPP, RMPP and GMPP was 79.71%, 80.23%and 64.74% respectively(p<0.01). Pulmonary complications were more likely to occur in FMPP. And there were significant differences among the three groups, including atelectasis (31.88%: 23.25%: 12.11%, P < 0.01) and pleural effusion (65.22%%: 32.56%%: 9.47%%, P < 0.01). However, the incidence of pleural thickening among three groups was not statistically significant(p>0.05).

Laboratory information	FMPP(n = 69)	RMPP(n = 86)	GMPP(n = 190)
WBC(× 10^9/L)	10.19 ± 4.61	8.312 ± 3.286*	8.757 ± 3.795**
Neutrophil, %	68.81 ± 13.32	62.620 ± 13.670*	60.321 ± 13.249**
CRP, mg/L	51.21 ± 49.59	26.273 ± 29.850*	23.771 ± 29.012**
LDH,IU/L	516.29 ± 221.37	471.92 ± 219.04	414.85 ± 168.83*
PCT,ng/ml	0.41 ± 0.68	0.22 ± 0.23	0.25 ± 1.31
IL-6,pg/ml	69.96 ± 115.23	32.13 ± 28.33*	21.29 ± 28.16**
La,mmol/l	2.82 ± 1.064	2.94 ± 1.13	3.00 ± 1.11
AST,U/L	48.68 ± 42.27	40.03 ± 29.15*	37.41 ± 41.25
ALT,U/L	47.17 ± 62.46	24.55 ± 27.43*	23.15 ± 48.36**
Fer,ng/L	421.61 ± 341.06	230.08 ± 265.68*	150.85 ± 167.70**
Fg,g/l	3.70 ± 1.15	4.27 ± 1.75	4.52 ± 1.77**
D-D,mg/L	1.94 ± 2.91	1.86 ± 4.41	0.49 ± 1.15**
*FMPP vs RMPP P < 0.05,**FMPP vs GMPP P < 0.05 data are represented by mean ± SD			

Table 2. Laboratory characteristic of FMPP, RMPP and GMPP patients

Table 3
Radiological features of FMPP, RMPP and GMPP patients

Radiological features	FMPP(n = 69)	RMPP(n = 86)	GMPP(n = 190)	P-value
Pulmonary consolidation	55(79.71%)	69(80.23%)	123(64.74%)	0.008
Lobar atelectasis	22(31.88%)	20(23.25%)	23(12.11%)	0.000
Pleural thickening	35(50.72%)	46(53.49%)	120(63.15%)	0.117
Pleural effusion	45(65.22%)	28(32.56%)	18(9.47%)	0.000
Data are presented as number (percentage).				

Clinical Course And Treatment Of Patients

Regarding the clinical course, the median duration of fever was 12 (range 9–14) days in FMPP group, 10 (range 8–12) days in RMPP group and 9 (range 8–10) days in GMPP group (P < 0. 01). And The median length of hospital stay was 12 (range 9–15) days in FMPP group, 9 (range 8–10) days in RMPP group and 6 (range 5–7) days in GMPP group (P < 0. 01). A total of 205 patients (57.90%) were treated with

glucocorticoid after admission, and the number of FMPP group was significantly higher than that in the other two groups (100% versus 84.06%,71.05% P < 0 01). The median length of starting glucocorticoid therapy were 10 (range 8–12) days in FMPP group, 9 (range 7–10) days in RMPP group and 9 (range 7–11) days in GMPP group (P < 0. 05). Fiberoptic bronchoscopy was performed in 201 cases (56.77%). Among them, 70 cases used fiberoptic bronchoscopy twice or more. The number of patients using fiberoptic bronchoscope in FMPP group was significantly higher than that in the other two groups (84.06% vs 70.93% vs 43.16% P < 0.01), and the number of patients which needed to use fiberoptic bronchoscope twice or more were significantly higher (57.97% vs 24.41% vs 4.74% P < 0.01). Additionally, the proportion of patients required oxygen-therapy and gamma globulin in the FMPP group was higher than that in the others(P < 0.01). All patients were treated with glucocorticoids, and there was no significant difference in the time of starting treatment among the three groups(p>0.05).(Table1)

Predictive values of the independent correlation factors in patients with FMPP

The ROC analysis was performed to explore predictive values of laboratory date for FMPP, and the critical value with maximum sensitivity and specificity was also determined. ROC analysis revealed that IL-6, ferritin and D-dimer were of great significance in the diagnosis of FMPP, the area of which under the curve were above 0.7.When the cut-off value for the IL-6, ferritin and D-dimer was set at 25.47 pg/ml, 171.15 ng/mL, and 0.45 μg/L, the sensitivity and specificity in recognized FMPP were 73.5% and 68.9%, 82.4% and 69.3%, 64.7% and 75.1%, respectively.

Table 4
Predictive values of the independent correlation factors in patients with FMPP.

Independent factors	Cutoff value	Sensitivity	Specificity	AUC	P-value
IL-6,pg/ml	25.47	0.735	0.689	0.737	0.000
Fer,ng/L	174.15	0.824	0.693	0.806	0.000
D-D,mg/L	0.450	0.647	0.751	0.720	0.000

AUC: area under the ROC curve; Cut-off value: the value on the ROC curve is closest to the upper right to take maximum sensitivity and specificity; Pvalue:the AUC value of the independent factors compared to ROC curve reference value 0.5.
the AUC value of the independent factors compared to ROC curve reference value 0.5.

Multiple Logistic Regression Analysis For The Related Factors Predicting the FMPP

For further evaluate the predictors associated with FMPP, multiple logistic regression was performed. IL-6 > 25.47 pg/ml ferritin > 174.15 ng/mL, and pleural effusion played a significant role in predicting the

FMPP, with the odd ratio (OR) values of 3.005,3.430, and 3.183, respectively in Table 5.

Table 5
Stepwise logistic regression analysis for the related factors predicting the RMPP

Variable	B	S.E.	Wald	P-value	OR	95%CI	
						Lower	Upper
IL-6,pg/ml	1.100	0.366	9.043	0.003	3.005	1.467	6.156
Fer,ng/L	1.233	0.409	9.066	0.003	3.430	1.538	7.653
Pleural effusion	1.158	0.383	9.122	0.003	3.183	1.502	6.749

Discussion

Mycoplasma pneumoniae pneumonia continues to be a significant cause of childhood community acquired pneumonia,and is usually a benign self-limited disease. On rare occasions, it manifests as fulminant disease that leads to death[6]. Fulminant or fatal mycoplasma pneumoniae have been reported for more than 50 years[7] ,death was associated with diffuse pneumonia, acute respiratory distress syndrome (ARDS), brain herniation, vascular thrombosis, and disseminated intravascular coagulation [7–11]. It is crucial to early diagnosis and early intervention for FMPP. However, there was still few studies on FMPP, especially in children. Therefore, we conducted a retrospective study, including 69 cases of FMPP group, and randomly selected 86 cases of RMPP group and 190 cases of GMPP group as control. All cases met the diagnostic criteria.

First of all, there was no significant difference in age and sex among the three groups, and the median age of the all groups was 6 years old, which was consistent with the age of high incidence of MPP[1].

Secondly, the signs and symptoms in FMPP group were more serious, and the incidence of extrapulmonary complications was higher (all $P < 0.05$). Dyspnea was the most common clinical manifestation of FMPP. In the study, the median time from onset to development of respiratory failure was 10 days(range 9–12),which was consistent with study of Izumikawa et al[5]. Some literatures have shown that liver function damage was the most common extrapulmonary complication of FMPP[12, 13]. In our research, 13 cases (18.84%) of FMPP complicated with liver function damage ($P < 0.05$). Moreover, M. pneumoniae infection might contribute to hypercoagulability and cause thrombosis itself, which was serious extrapulmonary complication[14]. In our research, 13 cases (18.84%) of FMPP had embolism ($P < 0.01$). These serious extrapulmonary complications also lead to longer hospitalization in patients with FMPP ($P < 0.01$).

Until now, the mechanisms of FMPP have been still uncertain. Izumikawa[15] believe that it was related to the immunological hyper-reaction in the lung, which may induce lymphocyte activation, resulting in

systemic impairment of cellular immunity and progression to fulminant status. In the laboratory indicators, the level of WBC, neutrophil ratio, CRP, LDH, IL-6 and ferritin were related to FMPP, which was similar to the previous case reports on FMPP [16–18]. Taken together, the evidence suggested a serious immune inflammatory reaction in FMPP.

The CT manifestations of mycoplasma pneumoniae pneumonia were various, mostly bronchial wall thickening, centrilobular nodules, ground-glass attenuation and consolidation[19]. In addition, our study showed that the imaging findings of FMPP were not specific, mainly pulmonary inflammatory consolidation (79.71%), but FMPP was more likely to be accompanied by atelectasis, pleural effusion (all $P < 0.01$), and aggravated in a short period of time. The result was similar with previous study. Miyashita et al indicated that bilateral infiltrates and pleural effusion commonly present in FMPP group compared to the other groups[13].It further suggested the severity of the disease, which may be related to the direct invasion of MP and excessive host immune response.

As for treatment, our study showed the number of people using glucocorticoid in FMPP group was significantly more than that in the other two groups (100% vs 84.06% vs 41.05%, $p < 0.05$), and only FMPP group used gamma immunoglobulin. Interestingly. our study suggested that there was no difference in the use of azithromycin among the three groups, which was contrary to prior research [5]. Therefore, we mainly believe that immune response plays an important role in the progression of MPP.

MP infection may cause varying degrees of respiratory mucus thrombus obstruction, even form bronchial molding, resulting in airway stenosis and occlusion[20]. We compared the incidence of plastic bronchitis between the three groups and found that FMPP group was significantly higher than the other two groups(52.17% vs 18.60% vs 1.05%,$p < 0.01$).So we think it may cause hypoxemia in MPP. Pediatric flexible fiberoptic bronchoscopy can clear respiratory secretions under direct view, relieve airway obstruction, and reduce the occurrence of complications. Therefore it has become an important method for the treatment and diagnosis of pediatric respiratory diseases[21]. In our study, a total of 201 children (58.26%) received fiberoptic bronchoscopy intervention therapy, among which the FMPP group received more and more times of this treatment($p < 0.01$). Furthermore, the MP-DNA examination of BALF can early identify the pathogen and diagnose it as soon as possible.

In our case, all the children recovered and discharged from hospital without death, which may be related to the early use of flexible fiberoptic bronchoscopy and appropriate doses of glucocorticoids.

In order to explore the related risk factors predicting FMPP, we used ROC curve and multivariate logistic regression analysis. ROC analysis revealed that the area under the curve of ferritin, IL-6 and D-dimer were above 0.7, which were helpful to recognize the patients in FMPP. And the optimal cutoff value for three factors was 174.15 ng/mL, 25.47 pg/ml and 0.45 μg/L, respectively. Besides, multiple logistic regression analysis was made to improve the predicted accuracy. We found that ferritin > 174.15 ng/mL, IL-6 > 25.47 pg/ml and pleural effusion were good predictors of FMPP. Ferritin not only represents iron reserves, but also an inflammatory marker[22]. When inflammation occurs, inflammatory factors act on the body to

increase the production of ferritin in serum. At the same time, inflammatory factors cause degeneration and necrosis of local tissue cells, dissolution and rupture of cell membrane, resulting in leakage of serum ferritin from damaged cells. As a result, ferritin is significantly increased in inflammatory response. However, there is still no report about the correlation of ferritin in FMPP. Some study[23] on RMPP reported when the ferritin level was 230 ng/mL or higher, the sensitivity and specificity for diagnosing refractory MP pneumonia were 67 and 67%, respectively. In our study, the optimal cutoff point for ferritin was 174.15 ng/mL, with a sensitivity of 82.4% and specificity of 69.3%, and the odds ratio of logistic regression analysis was 3.430. The reason for which made it different may be the presence of mixed infection in our case. IL-6 plays an important role in the early stage of immune response.In our study the area under the curve for IL-6 was 0.737, and the optimal cutoff point was 25.47 pg/ml, with a sensitivity of 73.5% and specificity of 68.9%, the odds ratio of logistic regression analysis was 3.005. Chen et al showed that the cutoff value of IL-6 for RMPP was 14.75 pg/ml[24] .At present, it is considered that the increase of IL-6 is related to the severity and course of the disease[25], which further suggests that there may be an excessive immune response in FMPP.

The advantage of this study is that we firstly explore the predictors with FMPP. Starting from the actual clinical cases, the differences between FMPP, RMPP and GMPP in large samples are compared and analyzed, and the interference of mixed factors is eliminated. It provides a strong basis for the early identification and treatment of FMPP, and has a certain degree of innovation and practicality.

There are several limitations to this study. Firstly, it was a retrospective study, and there may have been some selection bias. Secondly, there may be the presence of mixed infection in some cases which cannot be detected. Thirdly, the distribution of patients between the three groups is not matching, which might affect the statistic results. Therefore, In the future work, we should further carry out long-term multicenter, large sample prospective studies, and further explore the problems found in clinical work, so as to provide a reliable theoretical basis for early identification, early diagnosis and early intervention of FMPP.

Conclusion

Our study shows that excessive immunological inflammation may play an important role in FMPP. FER > 174.15 ng/mL, IL-6 > 25.47 pg/ml and pleural effusion were high risk factors for FMPP. Early and timely glucocorticoid therapy and bronchoscopy were helpful to the improvement of children's condition.

Abbreviations

FMPP, Fulminant Mycoplasma pneumoniae pneumonia; MPP, Mycoplasma pneumoniae pneumonia; RMPP, refractory Mycoplasma pneumoniae pneumonia; GMPP, general Mycoplasma pneumoniae pneumonia; PCR, polymerase chain reaction; CRP, C-reactive protein; LDH, lactic dehydrogenase; PCT, procalcitonin; IL, interleukin lactic acid; Fer, ferritin; Fg, fibrinogen; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ROC, Receiver operating characteristic

Declarations

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institution and/or national research committee. This article does not contain any studies with animals performed by any of the authors.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Competing interests

The authors declare no conflict of interest

Funding

No applicable

Authors' contributions

Conception and Design: Yaoyao Ling and Yongsheng Xu, Tongqiang Zhang; Extraction of Data: JiaoTian and Zhenli Zhu; Drafting the Article: Yaoyao Ling; Revising It for Intellectual Content: Yaoyao Ling and Yongsheng Xu; Final Approval of the Completed Article: Yaoyao Ling, Yongsheng Xu and Tongqiang Zhang. All authors read and approved the final manuscript.

Acknowledgements

We owe our thanks to Jiao Tian and Zhenli Zhu for their work on revising and data extracting in this manuscript.

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Figures

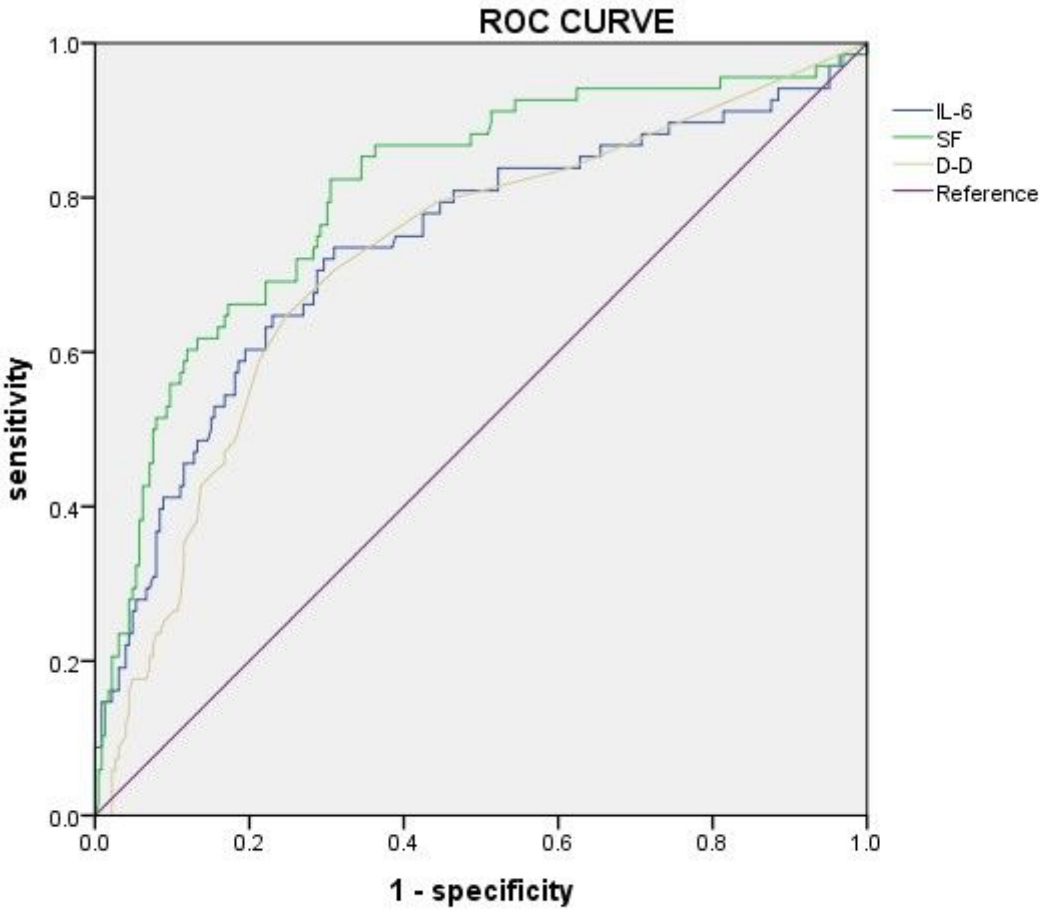

Figure 1

ROC Curve for predictive values of the independent correlation factors in patients with FMPP