Clinical characteristics and disease patterns of patients with relapsing polychondritis: a retrospective cohort

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Research Article

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Abstract

Background

Relapsing polychondritis (RP) is a rare autoimmune disease affected various cartilage, Patients with tracheal cartilage involvement are different from other patients. The objectives of this study were to allocated RP patients into two subgroups by chest computed tomography (CT) and compare the clinical features and disease patterns of each group.

Methods

A retrospective cohort study collected RP patients hospitalized at the Beijing Chao-Yang Hospital between January 2012 - August 2021. Patients were divided into two groups: respiratory involvement group and non-respiratory involvement group according to chest CT.

Results

In our study, respiratory involvement found in 59.7% (n=43) patients, which had higher rate of costochondritis, fewer rate of Inflammatory eye disease and auricular chondritis than those in non-respiratory involvement. Compared with non-respiratory involvement subgroup, The incidence of pulmonary infection marginally increased and those inflammatory indexes except for CAR were significantly higher in respiratory involvement subgroup, further subgroup analysis found that there was no significant relationship between inflammatory indexes and pulmonary infection. Finally, 5 patients died during the follow-up in this cohort with a median follow-up time of 6 years (range 3-8 years).

Conclusion

59.7% of patients had respiratory involvement according to chest CT findings in our cohort, which had a strong inverse relationship between respiratory and auricular, ocular involvement. Increase inflammatory indexes were not correlated with pulmonary infection, suggesting that patients with respiratory involvement had a higher disease activity index of RP. The probability of survival was not found significant in two subgroups.

Introduction

Relapsing polychondritis (RP) is a rare, systemic immune-mediated disease characterized by recurrent and progressive inflammation of the hyaline, elastic and fibrous cartilaginous structures, predominantly the external ear, nose, and tracheobronchial tree(1).Skin, cardiovascular system, nervous system, blood system may be affect. The first case of RP was reported by Jaksch-Wartenhorst in 1923, and Pearson et al introduced the term "RP" and summarized the common clinical manifestations in 1960(2). In a UK study, the incidence of RP between 1990 and 2012 was 0.71 per million population per year with a standardized mortality ratio of 2.16 (3) and the prevalence of RP in the Department of Defense beneficiary population was 4.5 per million(4).

Respiratory involvement was present in up to 50 % of RP patients(5, 6). Symptoms such as cough, stridor, progressive dyspnea and hoarseness were common in these patients, who were misdiagnosed as chronic bronchitis and refractory to conventional treatment, leading to a diagnostic dilemma and poor prognosis. Chest CT could reveal the classic morphologic respiratory changes associated with RP. Thus, the purpose of the present study was to retrospectively divide RP patients into 2 subgroups by chest CT findings, namely a subgroup of patients with respiratory involvement and a subgroup of patients with non-respiratory involvement, then describe and compare the clinical features and disease patterns of each subgroup.

Methods

Patient population

We retrospectively recruited RP patients who were admitted to the Beijing Chao-Yang Hospital from January 2012 to August 2021. RP was diagnosed according to the diagnostic criteria proposed by McAdam et al.(7), Damiani and Levine(8) and Michet et al.(9)(Table 1). Informed consent can be waived for this retrospective study with the approval of the the ethics committee.

Data acquisition

Data were obtained from the Electronic Medical Records (EMR). Patients younger than 18 years or without complete electronic case files were excluded. Patients with other connective tissue disease were also excluded. The clinical data were collected for all patients from medical records: patients' profiles, clinical features, chest CT scan, blood test, autoimmune series including rheumatoid factor (RF), antinuclear antibodies (ANA), anti-dsDNA antibodies, antineutrophil cytoplasmic antibodies (ANCA) and therapeutic interventions.

Subgroup definition

All patients performed chest computed tomography and respiratory involvement in our study included respiratory wall thickness or calcification and respiratory stenosis due to the lack of end-inspiratory and dynamic expiratory scans. Respiratory wall thickness was defined as the thickness of the wall of the involved respiratory segment was greater than 2 mm, respiratory narrowing was defined as at least a 25% reduction in the diameter of the lumen(10).

Statistical analysis

The descriptive analysis included the absolute and relative (percentage) frequencies for the categorical variables, the means (standard deviations, SD) and medians (interquartile ranges, IQR) for the quantitative parametric. Differences between the groups were computed using the Student's t test or Fisher's exact test for quantitative variables and the chi-square test for the qualitative variables and the Mann–Whitney or Kruskal–Wallis tests for the non-normal variables. Spearman correlation coefficient was used to describe the correlation between two categorical variables. Kaplan-Meier (K-M) survival

analyses and Log-rank test were constructed to reveal survival analysis. Multiple imputation was performed on missing data. All analyses were performed using SPSS software version 21.0 and GraphPad Prism version 7.0 Two-tailed, p-value < 0.05 was considered statistically significant.

Results

From January 2012 to August 2021, 75 patients with RP were screened in this study. 2 patients with positive for ANCA against MPO (myeloperoxidase) diagnosed as Systemic vasculitis and 1 patient with positive for ANCA against PR3 (proteinase-3) diagnosed as ANCA associated vasculitis were excluded. The diagnosis based on Damiani and Levine's criteria was confirmed in 45 patients (62.5%), either Michet or Damiani criteria were fulfilled in 66 patients (91.6%). 16 patients (22.2%) met all the three criteria, 6 (8.3%) patients did not fulfil any set of criteria, but the improvement of auricular inflammation and respiratory symptoms after corticosteroid treatment was typical for RP. We reviewed previous chest CT images and found respiratory wall thickening sparing the posterior membranous wall was identified in 43 patients (59.7%) (Figure.1 a), respiratory wall calcification sparing the posterior membranous wall was identified in 24 patients (33.3%) (Figure.1 b and b), respiratory stenosis was identified in 10 patients (13.8%) (Figure.1 d), 29 (40.3%) patients did not show the above typical CT findings of RP. Thus, there were 43 (59.7%) and 29 (40.3%) patients in the respiratory involvement and non-respiratory involvement subgroups. 64 patients received treatments, with a base of prednisone of 0.5-1mg/Kg/d, 25%(n=18), 19.4%(n=14) of patients were being treated with methotrexate (MTX) and cyclophosphamide (CYC), respectively.

Demographic characteristics

A total of 42 male and 30 female patients were included in our study, 29 of 72 patients smoked. The average age at the time of first symptoms was 54.03±13.10 years and the average age at diagnosis was 55.20±12.59 years. The delay from the time of the first symptom to the diagnosis was 6(2-24) months, and the duration of follow-up since the establishment of diagnosis was 4 (3-6) years. Finally, 5 patients died during the follow-up. We did not find significant differences in the demographic features of two subgroups (Table 2).

Subgroup analyses of clinical characteristic and correlation analysis

Respiratory involvement (n=43) and auricular chondritis (n=26) were the most frequent manifestations, followed by ocular involvement consisting of scleritis and uveitis (n=18), sensorineural hear loss (n=18), costochondritis (n=14), nasal chondritis (n=11). Patients in respiratory involvement subgroup had a significantly higher occurrence of costochondritis (p=0.03) and a less occurrence of auricular chondritis (p=0.001), Inflammatory eye disease (p=0.001) than non-respiratory involvement subgroup. Laryngeal involvement in 8 patients, Inflammatory arthritis in 6 patients, Cutaneous manifestations in 4 patients were other common seen manifestations, there was no significant difference in above clinical manifestations between the two groups. Although not statistically significant, there was a clear trend toward a higher frequency of pulmonary infection in respiratory involvement subgroups (p=0.06). Cardiac

involvement in the form of myocardial infarction or ventricular tachycardia was seen in 4 patients. One patient developed cytopenia after treatment with glucocorticoids and immunosuppressants, Bone marrow biopsy showed bone marrow suppression.

We performed correlation analysis between different organ involvement and found a negative correlation between respiratory involvement and auricular chondritis ($r=-0.58$, $p < 0.01$), and also between respiratory involvement and inflammatory eye disease ($r=-0.45$, $P < 0.01$). Auricular chondritis was positively correlated with inflammatory eye disease ($r=0.49$, $P < 0.01$) A weak positive correlation was also revealed between auricular chondritis and pulmonary infection ($r=-0.39$, $P < 0.05$). (Figure.2)

Comparisons of laboratory findings and subgroup analysis

The respiratory involvement subgroup had higher CRP and ESR concentrations than non-respiratory involvement subgroup ($p=0.03$, $p=0.04$). Creatinine and Uric acid in the non-respiratory involvement subgroup were significantly higher than in respiratory involvement subgroup ($p=0.02$, $p=0.01$). Novel inflammatory markers associated with RP disease activity index NLR, PLR were higher in respiratory involvement subgroup ($p=0.03$, $p=0.01$), but CAR was lower ($p=0.04$, $p=0.01$). We further conducted subgroup analysis on whether patients with respiratory involvement had pulmonary infection, and found no statistical difference in inflammatory indicators between the two groups of patients. (Table.3)

PFTs were performed in 22 patients with respiratory involvement, and showed respiratory obstruction in all patients, obviously reducing in forced expiratory volume in 1 second (FEV1) 1.21±0.54L, forced expiratory volume in 1 second/forced vital capacity (FEV1/FVC) 42.11±14.84%, Residual volume (RV), total lung capacity (TLC), Residual volume /total lung capacity (RV/TLC) were usually normal.

Positive antinuclear antibodies were found in 8 patients in a titre of 1: 320, rheumatoid factor was positive in 4 patients, antineutrophil cytoplasmic antibodies were positive in 4 patients, but no particular specificities were found.

Survivals

After a follow-up period of 6 (3-8) years since the first symptoms, 6.9% of the patients (n = 5) had died (Table.2), K-M curve and Log-rank test also showed the probability of survival was not statistically different between patients with and without respiratory involvement (Figure.3).

Discussion

In the present study, we compared the clinical features and disease patterns of RP patients with or without respiratory involvement. We found that RP is equally prevalent in men and women, with onset occurring between the ages of 40-60, which is consistent with other series (4, 11). Age at the time of first symptoms, the time of the first symptom to the diagnosis and age at diagnosis were also no significant differences between two groups. Respiratory involvement subgroup was characterized by higher rate of costochondritis, fewer Inflammatory eye disease and auricular chondritis compared to non-respiratory

involvement. Respiratory involvement subgroup trended towards significantly increasing the likelihood of pulmonary infection. CRP, ESR and novel inflammatory markers associated with RP activity index (NLR, PLR) were higher in respiratory involvement subgroup, but CAR was Lower. The level of Creatinine and Uric acid were higher in non-respiratory involvement subgroup. PFTs suggested that patients with respiratory involvement had obvious ventilation dysfunction, and gas exchange was not involved. 64 patients received treatments, with a base of prednisone of 0.5-1mg/Kg/d, 25%(n=18), 19.4%(n=14) of patients were being treated with MTX and CYC, respectively. The median follow-up period was 6 years (ranger 3-8 years), 5 of the patients had died, the probability of survival was not statistically different between two subgroups.

RP is a rare autoimmune disease characterized by recurrent inflammation and destruction of cartilage(12). The cause of RP is uncertain but regarded as autoimmune-mediated(13). Although anti-Collagen Type II antibodies, matrilin-1, cartilage oligomeric matrix proteins could be found in the targeted cartilage, the above antibodies are not specific and not used in clinical practice(13-17). There is no validated classification for RP, the diagnosis depends on a combination of clinical representation, imaging and biopsy of involved cartilaginous tissues. Ernst(18) investigated 145 RP patients and found 21% of patients had respiratory involvement, but respiratory symptoms were the first symptom in 54% of these patients. Dion(19) performed a retrospective study of 142 RP patients using a cluster analysis in France to identified three separate phenotypes: hematological phenotype, respiratory phenotype, mild phenotype and found that 22% of RP patients exhibited respiratory manifestations and thought that patients in the respiratory phenotype frequently received intensive treatments and suffered from more infections, which had been considered as a significant cause of mortality in previous studies. Recently, one study(20) included 239 RP patients found 19.7% and 29.3% of these patients in the respiratory involvement without auricular involvement subgroup and both respiratory and auricular involvement subgroup, respectively. The above studies defined respiratory involvement by the patterns of clinical manifestations. Meanwhile, a good agreement was found between clinical and radiographic data for the diagnosis and assessment of disease activity in RP patients(21). A review(10) suggested that chest CT scan particularly with end-inspiratory and dynamic expiratory scans should be routinely performed at diagnosis and during the evolution of the disease. Malacia or air trapping may be the unique CT abnormalities(22, 23), which could be more easily detected during dynamic expiration scan. In our study, 43 patients were found thickening of anterior and lateral respiratory walls, which was considered to be the early stage of the disease(17), increased attenuation of the cartilages sparing the posterior membranous wall and respiratory stenosis was identified in 24 patients,10 patients.

Consistent with studies in the French and Japanese patients(19, 20), our current study demonstrated there were obvious differences between two subgroups in terms of clinical characteristics: Respiratory involvement subgroup was characterized by laryngotracheal chondritis and costochondritis, non-respiratory involvement subgroup was distinguished by inflammatory eye disease and auricular chondritis. We also found five patients with auricular chondritis or inflammatory eye disease were assigned to the respiratory involvement subgroup, due to their chest CT showed respiratory wall thickening, calcification or stenosis. We didn't do a further subgroup analysis on account of small

quantity, those patients may require to be isolated and analyzed as well as the Overlap subgroup (20). In contrast to other studies(4, 7, 24-26), involvements of skin (5.6 %: 13–46 %) and cardiovascular involvements (5.6 %: 2–31 %) were less common. Chang-Miller et al(27) reported renal involvement was observed in 29 of 129 patients, however, renal involvement were not present in our study, but uric acid and creatinine levels were higher in the non-respiratory involvement subgroup, reminding possible kidney damage.

Although RP is considered to be an immune system disease, no significant abnormalities have been found in either cellular or humoral immunity. CRP and ESR are markers of the severity of common rheumatic diseases, Higher CRP and ESR concentrations in the respiratory involvement subgroup suggested more inflammation and disease activity. Novel inflammatory markers were associated with activity in many rheumatic diseases(28, 29). Cao(30) indicated that CAR, NLR and PLR levels were significantly higher in RP patients than healthy controls and were positively correlated with RPDAI. We found that NLR, PLR were higher in respiratory involvement subgroup, but CAR was lower compared to non-respiratory involvement subgroup. Subgroup analysis of patients with respiratory involvement found that there was no statistical difference between pulmonary infection and inflammation indexes suggesting those patients had a high level of disease activity.Our study had some limitations. Firstly, it was a single-center, retrospective study, with a small sample size. Secondly, Air trapping or Mosaic sign occurred in the early stages of RP. In our study, when RP was diagnosed without dynamic expiration, Air trapping or Mosaic sign cannot be detected in time and may result in a delay in diagnosis

In Conclusion, 59.7% of patients had respiratory involvement according to chest CT findings in our cohort, which had a strong inverse relationship between respiratory and auricular, ocular involvement. Increase inflammatory indexes were not correlated with pulmonary infection, suggesting that patients with respiratory involvement had a higher disease activity index of RP. The probability of survival was not found significant in two subgroups.

Abbreviations

RP: Relapsing polychondritis; CT Computed tomography; CAR: C reactive protein to albumin ratio; EMR: Electronic Medical Records; RF: rheumatoid factor; ANA: antinuclear antibodies ; ANCA: antineutrophil cytoplasmic antibody; SD: standard deviations ; IQR: interquartile ranges; MPO: myeloperoxidase; PR3: proteinase-3; MTX: methotrexate; CYC: cyclophosphamide; CRP: C-reactive protein; ESR: erythrocyte sedimentation rate; NLR: neutrophil to lymphocyte ratio; PLR: platelet to lymphocyte ratio; PFTs: Pulmonary function tests; FEV1: forced expiratory volume in 1 second; FVC: forced vital capacity; RV: Residual volume; TLC: total lung capacity

Declarations

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Not applicable.

AUTHOR CONTRIBUTIONS

DW and LJG participated in the study design, performance, and manuscript writing. XFZ conducted medical data collection, XD participated in patient screening as a rheumatologist, ZHT revised the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

Raw data is available from the corresponding author on reasonable request

Ethics approval and consent to participate

Informed consent can be waived for this retrospective study with the approval of the the medical Ethics Committee of the Chaoyang Hospital, Beijing.

Consent for publication

Not applicable.

Competing interests

None of the investigators declare any real or perceived conflicts of interest pertaining to the subject of this manuscript.

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Tables

Table 1 Three sets of diagnostic criteria for relapsing polychondritis	
McAdam et al.	bilateral auricular chondritis
	nonerosive seronegative inflammatory arthritis
	nasal chondritis
	ocular inflammation
	respiratory tract chondritis
	audio-vestibular damage
	≥ three symptoms
Damiani and Levine	three symptoms of the McAdam's criteria
	one symptom of McAdam's criteria and histologic evidence of chondritis
	chondritis at two or more separate anatomic locations with response to corticosteroids, dapsone, or both
Michet et al	two out of three symptoms: Auricular cartilage inflammation, Nasal cartilage inflammation, Laryngotracheal cartilage inflammation
	one of the above and meeting two other signs: ocular inflammation, hearing loss, vestibular dysfunction, or seronegative inflammatory arthritis (any of these)

Table 2 Comparison of patients with respiratory involvement and non- respiratory involvement

Variables	All patients (n=72)	Non-airway involvement (n=29)	airway involvement (n=43)	P value
Male	42(58.3%)	19(65.5%)	24(55.8%)	0.26
Smoke	29(40.3%)	11(37.9%)	18(41.9%)	0.73
Age at the time of first symptoms (years)	54.03±13.10	56.36±16.18	52.48±10.71	0.39
The time of the first symptom to the diagnosis (months)	6(2-24)	4.5(2-15)	7(2-24)	0.52
Age at diagnosis(years)	55.20±12.59	57.29±15.44	53.81±10.45	0.43
Clinical features, n (%)				
Laryngeal involvement	8(11.1%)	2(6.9%)	6(14%)	0.35
Auricular chondritis	26(36.1%)	19(65.5%)	7(16.2%)	0.001*
Inflammatory arthritis	6(8.3%)	2(6.8%)	4(9.3%)	0.72
Nasal chondritis	11(15.3%)	4(13.8%)	7(16.3%)	0.77
Inflammatory eye disease	18(25%)	13(44.8%)	5(11.6%)	0.001*
Sensorineural hear loss	18(25%)	10(34.5%)	8(18.6%)	0.13
Cutaneous manifestations	4(5.6%)	2(6.9%)	2(4.7%)	0.68
Costochondritis	14(19.4%)	2(6.9%)	12(27.9%)	0.03*
Fever	26(36.1%)	11(37.9%)	15(34.9%)	0.79
Pulmonary infection	14(19.4%)	3(10.3%)	11(25.6%)	0.06
Myocardial infarction	4(5.6%)	2(6.9%)	2(4.7%)	0.65
Laboratory findings				
IgG (mg/dl)	1139.82±317.57	1062.2±307.62	1187.87±321.38	0.27
IgA (mg/dl)	272.5(182.5-370.25)	266(93.45-318)	277(190.5-405.5)	0.40
IgM (mg/dl)	78..35(61.45-130.25)	73.1(61.75-114.55)	82.8(60.2-132)	0.68
C3 (mg/dl)	109.72±21.34	102.86±18.31	113.97±22.38	0.14
C4 (mg/dl)	28.8(22.45-34.18)	25.61 (22-30.65)	29.31(22.3-35.75)	0.26
Albumin (g/L)	36.31±5.80	37.04±7.36	35.85±4.73	0.57

Total cholesterol (mmol/l)	4.23(3.85-5.09)	4.67(3.72-5.09)	4.12(3.83-5.11)	0.62
HDL-C (mmol/l)	1.1(0.8-1.59)	1.1(0.87-1.65)	1.02(0.77-1.54)	0.51
LDL-C (mmol/l)	2.75(2.48-3.32)	2.8(2.2-3.1)	2.72(2.53-3.77)	0.68
Triglyceride (mmol/l)	1.04(0.8-1.23)	1.09(0.85-1.34)	0.98(0.74-1.11)	0.08*
LDH (u/l)	190.5(158.75-216.25)	191(170-214.5)	190(140.5-229)	0.83
Creatinine (umol/l)	61.1(49.13-70.13)	69.8(50.5-79.35)	55.8(44.35-66.25)	0.02*
Uric acid (umol/l)	266.85±89.99	320.15±88.02	233.88±75.66	0.01*
HbA1c (%)	5.95(5.52-7.34)	5.9(5.51-7.45)	6(5.55-7.57)	0.62
White blood cells ($10^{\wedge 9}$)	8.06(6.54-10.05)	7.18 (5.64-10.66)	8.16 (7.04-9.57)	0.4
Neutrophils ($10^{\wedge 9}$)	5.77(4.23-7.58)	5.61(3.05-7.07)	6.21(4.51-8)	0.23
Lymphocyte ($10^{\wedge 9}$)	1.48(0.87-2.19)	1.85 (0.99-2.86)	1.32 (0.87-2.01)	0.29
Monocyte ($10^{\wedge 9}$)	0.47 (0.41-0.66)	0.43 (0.38-0.72)	0.47 (0.44-0.68)	0.4
Hemoglobin (g/l)	124.4±21.8	122.38±28.68	123.95±14.87	0.84
Platelet ($10^{\wedge 9}$)	289.5(190.75-355.02)	245(175-311)	298(267.5-376.5)	0.15
CRP (mg/l)	2.31(0.61-8.19)	0.96(0.43-4.50)	3.96(1.74-9.78)	0.03*
ESR (mm/h)	25.5(13.75-44)	20 (13-28)	30(14-60.5)	0.04*
CAR	0.07(0.19-0.26)	0.23(0.14-0.11)	0.11(0.04-0.29)	0.04*
NLR	4.26(1.78-7.06)	1.80(1.47-6.08)	4.46(3.02-9.05)	0.03*
PLR	197.59(124.29-286.34)	132.43(76.10)-202.32	223.08(185.8-7-334.14)	0.01*
Outcomes				
Mortality	5(6.9%)	2(6.9%)	3(7%)	0.72

Note: Data are presented as median (interquartile range), mean (standard deviation) or n (%)

Abbreviations: HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; LDH, lactate dehydrogenase; CRP, c-active protein; ESR, erythrocyte sedimentation rate; CAR C reactive protein to albumin ratio; NLR neutrophil to lymphocyte ratio

PLR platelet to lymphocyte ratio

*p<0.05

Table3. Subgroup analysis of respiratory involvement patients with pulmonary infection or without pulmonary infection

	Without pulmonary infection (n=32)	With pulmonary infection (n=11)	p
CRP (mg/l)	4.35(2-8.4)	3.49(0.7-10.7)	0.81
ESR (mm/h)	37.5(25-58.3)	24(13-62)	0.46
CRP/Albumin	0.11(0.05-0.31)	0.09(0.02-0.29)	0.38
Neutrophil/lymphocyte	4.11(2.51-10.04)	5.06(3.91-8.23)	0.55
Platelet/Lymphocyte	243.8(185.45-453.12)	209.85(181.31-288.53)	0.91

Note: Values are median (IQR).

Abbreviations: CRP, c-active protein; ESR, erythrocyte sedimentation rate CAR C reactive protein to albumin ratio; NLR neutrophil to lymphocyte ratio; PLR platelet to lymphocyte ratio

*p<0.05

Figures

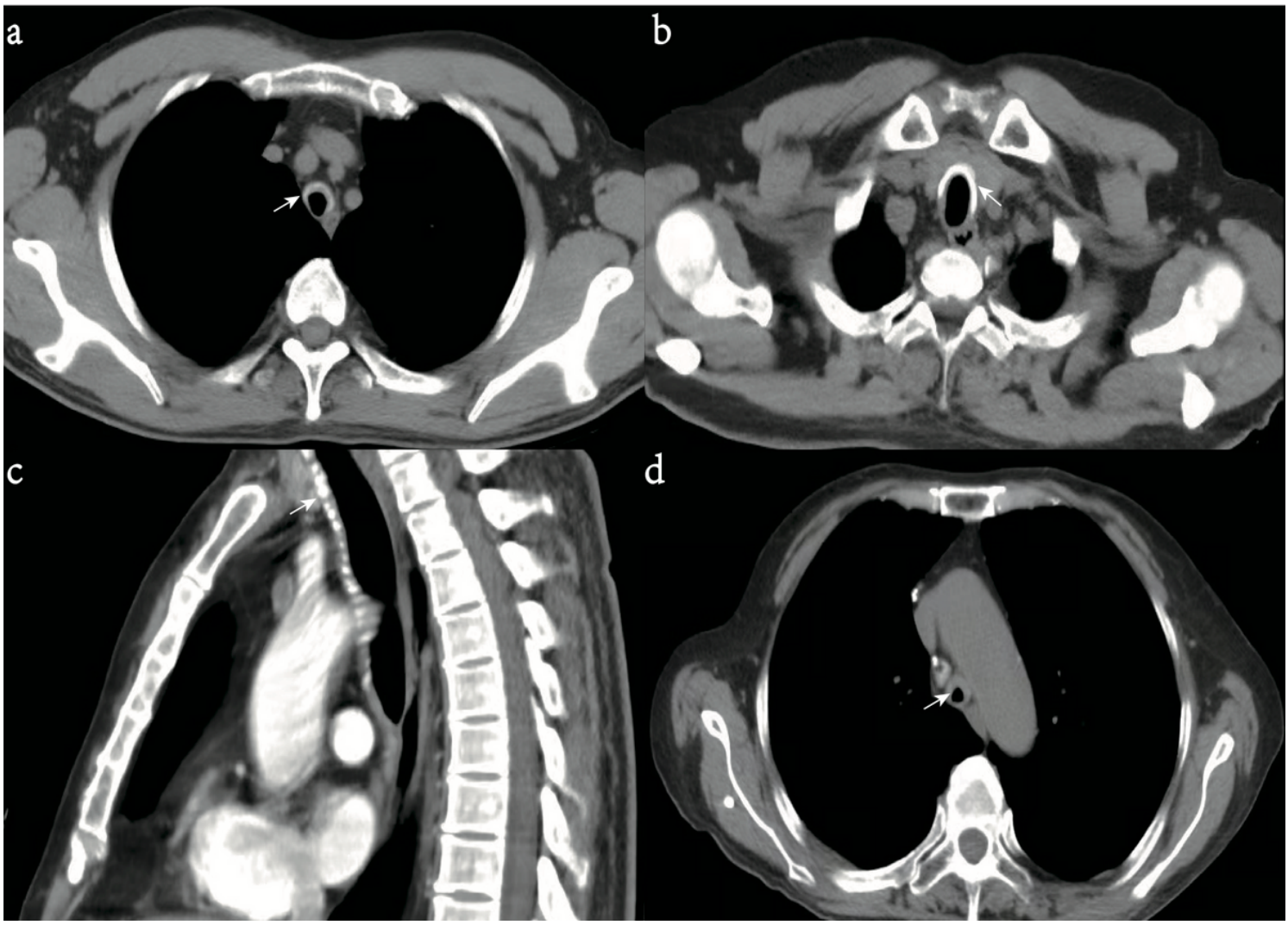

Figure 1

chest CT scan of respiratory involvement RP patients.

Axial CT slices showing (a) thickening of the anterior and bilateral wall of the upper trachea(arrow), (b) tracheal wall thickening contains calcific deposits (arrows). (c) Coronal CT reconstruction showing diffuse thickening of the anterior wall of the trachea and main bronchi, with calcifications(arrow) (d) Axial CT slices showing major stenosis of the main bronchi lumen (arrow)

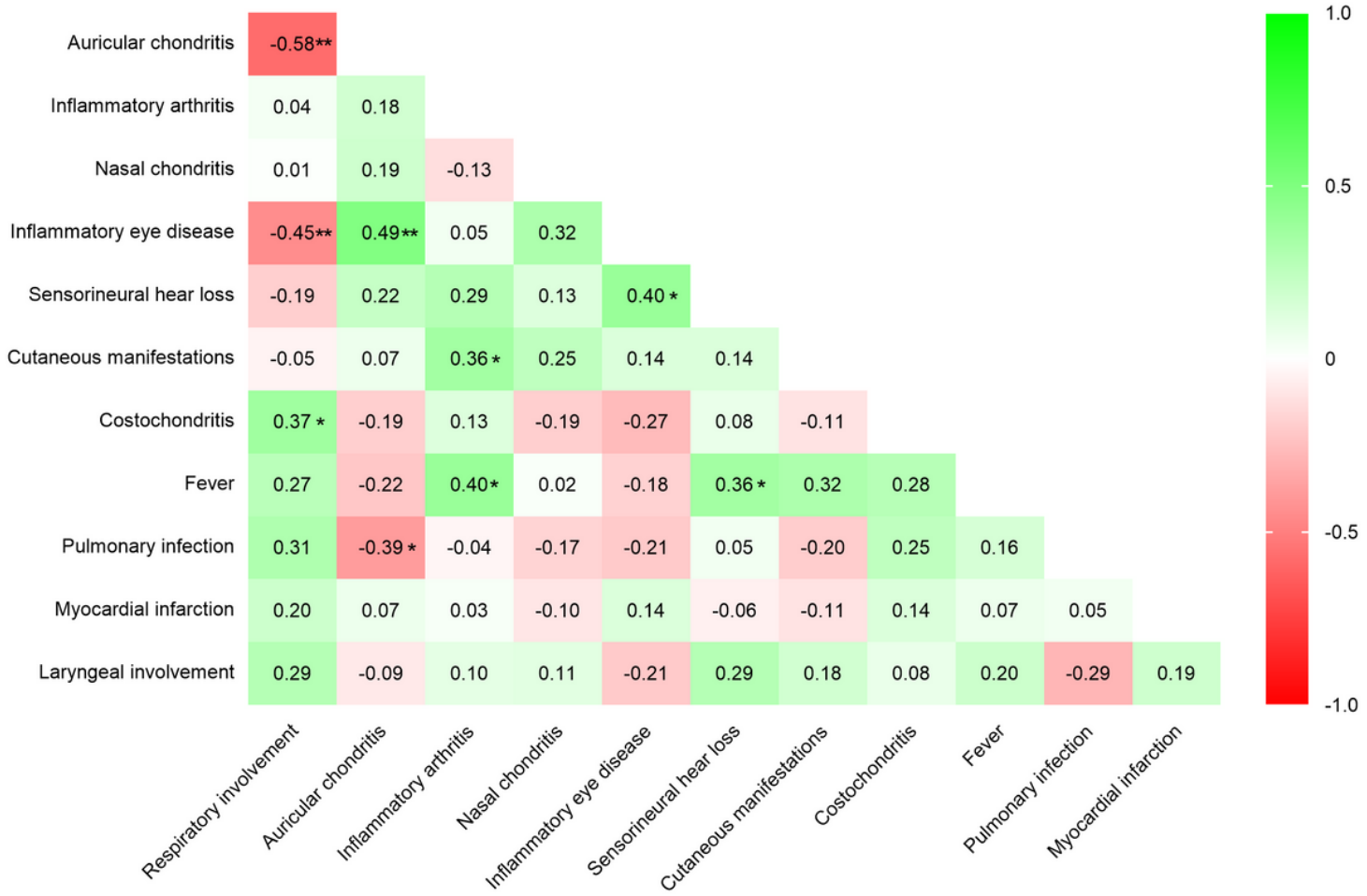

Figure 2

Correlation analysis of different organ involvement

* P < 0.05; ** P < 0.01

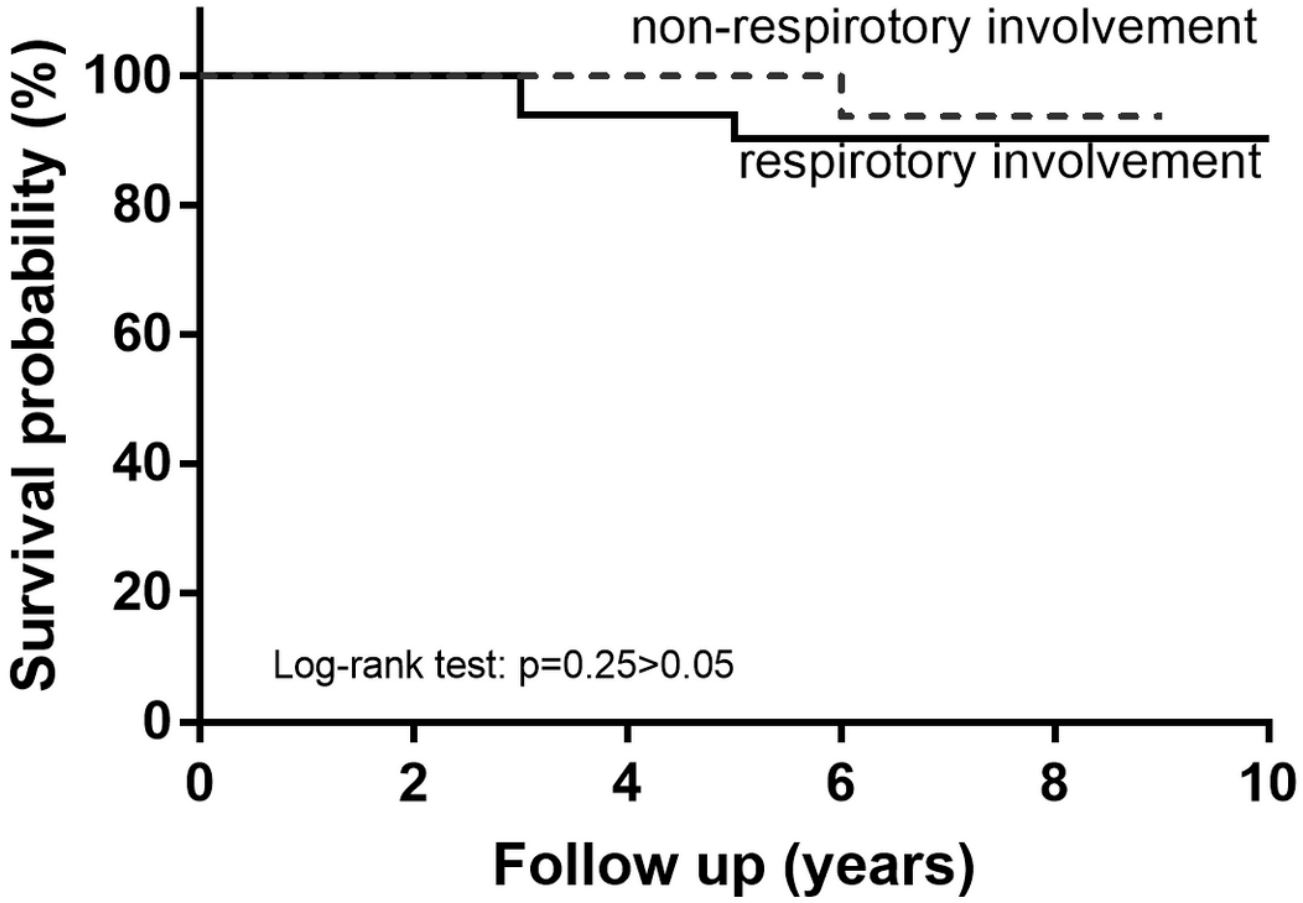

Figure 3

Kaplan–Meier survival curve and Log-rank test of respiratory involvement and non-respiratory involvement RP patients

* P < 0.05; ** P < 0.01