^{129}Xe MR Evidence of Abnormal Gas-exchange in Moderate and Severe Asthma

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Introduction

- Asthma is a chronic airway inflammatory disease
- Abnormal alveolar collagen deposits[1] and pulmonary vascular remodeling[2] in poorly-controlled asthma suggest abnormalities may extend beyond the airways
- ^{129}Xe MR spectroscopy provides a way to quantify transmembrane diffusion into alveolar-capillary interface where ^{129}Xe competitively binds to RBC in the blood[3]
- Previous ^{129}Xe MRS investigation identified gas-exchange abnormalities in chronic lung disease[4]
- ^{129}Xe MRS measurements of gas-exchange including micro-perfusion not yet investigated in patients with moderate-severe asthma

Hypothesis

^{129}Xe MRS gas-exchange measurements are significantly different in healthy volunteers and patients with asthma

Methods

- Asthma classified by Global Initiative for Asthma (GINA)[5]
- Participants with no chronic lung disease (n=23) and participants with moderate (GINA 4; n=27) and severe (GINA 5, n=18) asthma provided written informed consent
- Pulmonary function tests and MRI performed pre-post BD; MRI ventilation defect percent (VDP) quantified[6]
- MR spectroscopy peaks fit to three-component Lorentzian model to determine full-width half maximum, phase, frequency[7]
- Intergroup differences evaluated using analysis of variance (ANOVA) and univariate relationships determined using Spearman (ρ) correlations

Results

Figure 1. ^{129}Xe MR spectroscopy A) Gas or ventilation signal; B) Membrane signal; C) RBC or pefusion signal

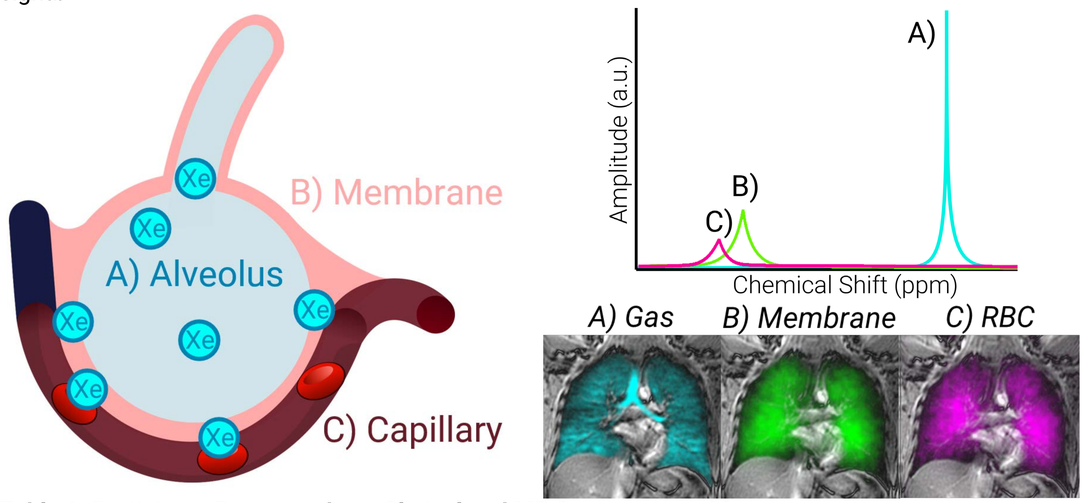

Table 1. Participant Demographics, Clinical and MR Spectroscopy Measurements

Parameter mean(±SD)	All (*n=68*)	Healthy (*n=23*)	GINA 4 (*n=27*)	GINA 5 (*n=18*)	*ANOVA P-value*	*G4 vs G5 P-value*
Age [years]	47 (19)	30 (13)	54 (15)	60 (14)	<.001	.1
Females [n(%)]	47 (70)	10 (43)	23 (77)	14 (77)	.02	.9
BMI [kg/m^2]	28 (6)	24 (4)	31 (7)	29 (5)	.005	.5
FEV_1 [L]	2.7 (1.1)	3.9 (0.8)	2.1 (0.7)	2.1 (0.7)	<.001	.8
FEV_1 [$\%_{pred}$]	82 (21)	96 (13)	72 (19)	80 (23)	<.001	.2
FVC [L]	3.7 (1.3)	4.8 (1.2)	3.3 (1.0)	3.0 (0.8)	<.001	.2
FVC [$\%_{pred}$]	92 (16)	98 (12)	87 (13)	90 (21)	.03	.6
FEV_1/FVC	72 (13)	82 (7)	65 (12)	70 (10)	<.001	.2
DL_{CO} [$\%_{pred}$]	118 (18)	118 (18)	-	-	-	-
Eos [cells/μL]	466 (354)	-	374 (236)	583 (445)	.08	.08
RBC : M	0.37 (0.12)	0.46 (0.12)	0.34 (0.10)	0.29 (0.08)	<.001	.048
M : Gas	0.92 (0.24)	0.96 (0.27)	0.88 (0.25)	0.93 (0.19)	.4	.4
RBC : Gas	0.35 (0.16)	0.45 (0.19)	0.30 (0.11)	0.28 (0.10)	<.001	.5

BMI=body mass index; FEV_1=forced expiratory volume in 1 sec; $\%_{pred}$=percent of predicted value; FVC=functional vital capacity; DL_{CO}=diffusing capacity of carbon monoxide; Eos=eosinophilic cell count; RBC=red blood cell; M=alveolar-capillary membrane.

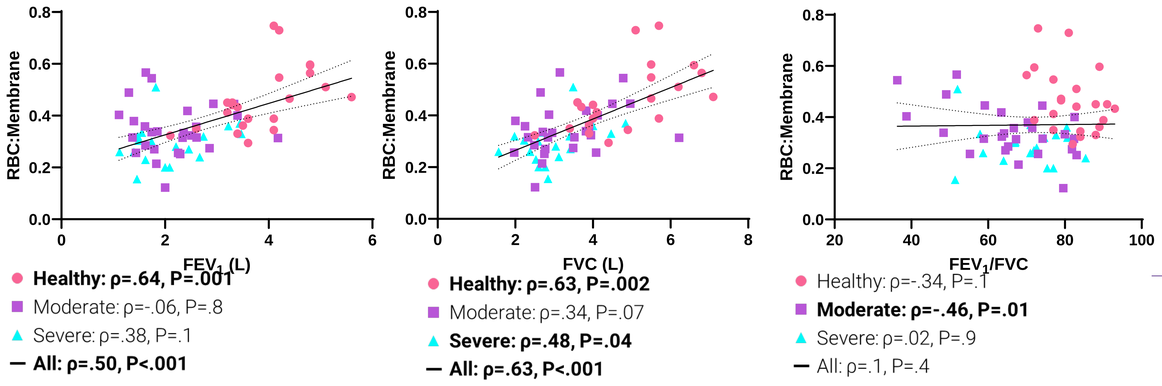

Figure 2. Spearman correlations for dissolved-phase RBC:Membrane measurement in healthy, moderate (GINA 4), severe (GINA 5) asthma.

Discussion

- ^{129}Xe MRS gas-exchange measurements significantly different in healthy volunteers, moderate and severe asthma patients
- RBC:M differed between participants with GINA-4 and GINA-5 asthma severity
- Differences driven by RBC measures as no difference in M:Gas signal between groups
- Abnormally low RBC:M in asthma correlated with airflow obstruction
- RBC:M sensitively reflects abnormal gas-exchange which was previously reported in non-specific interstitial pneumonia, and related to FVC in idiopathic pulmonary fibrosis[8,9]
- Gas-exchange and vascular abnormalities suggest pulmonary vascular remodeling, chronic or acute hypoxic vasoconstriction, and/or shunt
- MRI gas-exchange may serve as a novel pathophysiologic finding in moderate-severe asthma

Conclusion

^{129}Xe MRS gas-exchange abnormalities differ in healthy volunteers and patients with moderate or severe asthma

References

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