The hemodynamic effect of simulated atrial fibrillation on left ventricular function

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Background

- Atrial fibrillation (AF) significantly impairs the cardiac performance.
- Pathophysiological mechanisms: the loss of atrial kick, shortening of left ventricular (LV) diastolic filling, or heart rhythm irregularity causing neurohumoral activation.
- Aims: To assess the relative hemodynamic contribution of each of these components during in-vivo simulated human AF.

Methods

12 pts undergoing PVI for paroxysmal AF

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Pacing protocols (at a rate of 90bpm and 130bpm):
- Regular atrial pacing [sinus rhythm]
- Regular simultaneous A and V pacing [loss of atrial kick]
- Irregular simultaneous A and V pacing SDRR 20% and SDRR 30% [atrial fibrillation]

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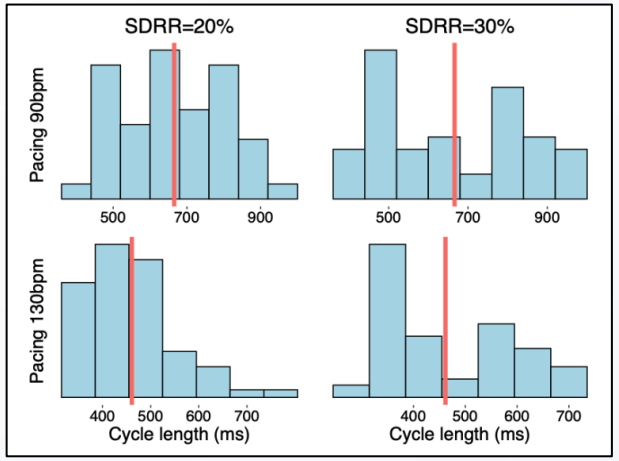
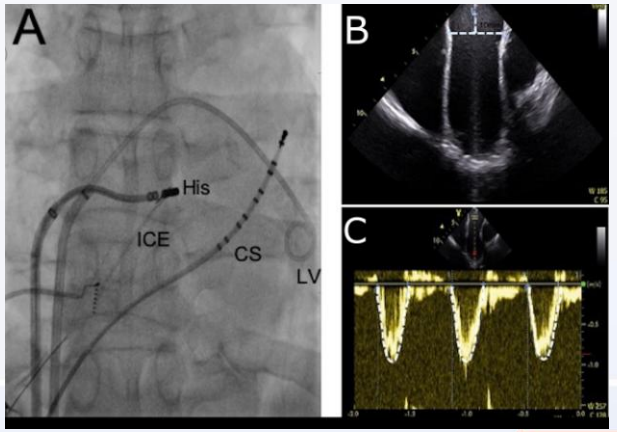
Hemodynamic study
- blood pressure (SBP), LV end-diastolic pressure (LVEDP), LV dP/dT max, and Tau
- mean left atrium (LA) pressure
- cardiac output (CO) and cardiac index (CI)





Baseline characteristics

	N = 12
Age (years)	59 ± 5
Male gender	8 (67%)
Body mass index (kg/m2)	29 ± 3
Arterial hypertension	6 (50%)
Diabetes mellitus	2 (16%)
History of stroke	2 (16%)
Antiarrhythmic drugs	5 (41%)
CHADS2-VASc score	1.7 ± 1.5
Left ventricular ejection fraction (%)	55 ± 9
Left atrial volume (ml/m2)	39 ± 9

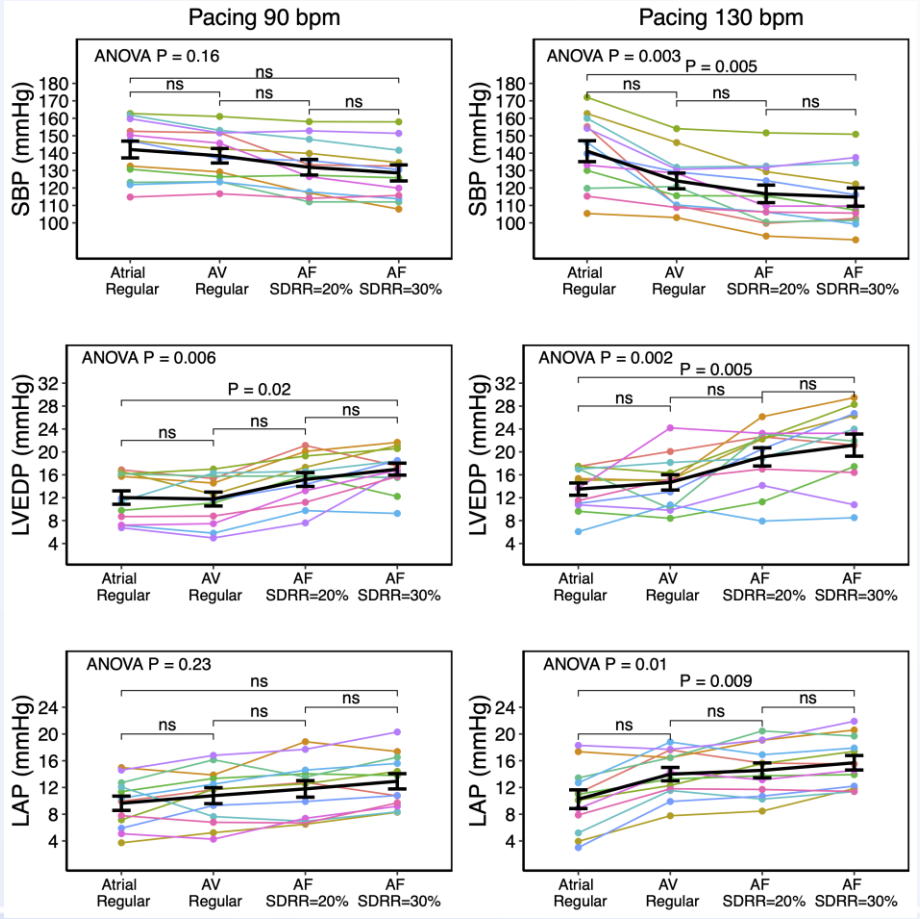
Data are provided as means ± standard deviations or counts (proportions).

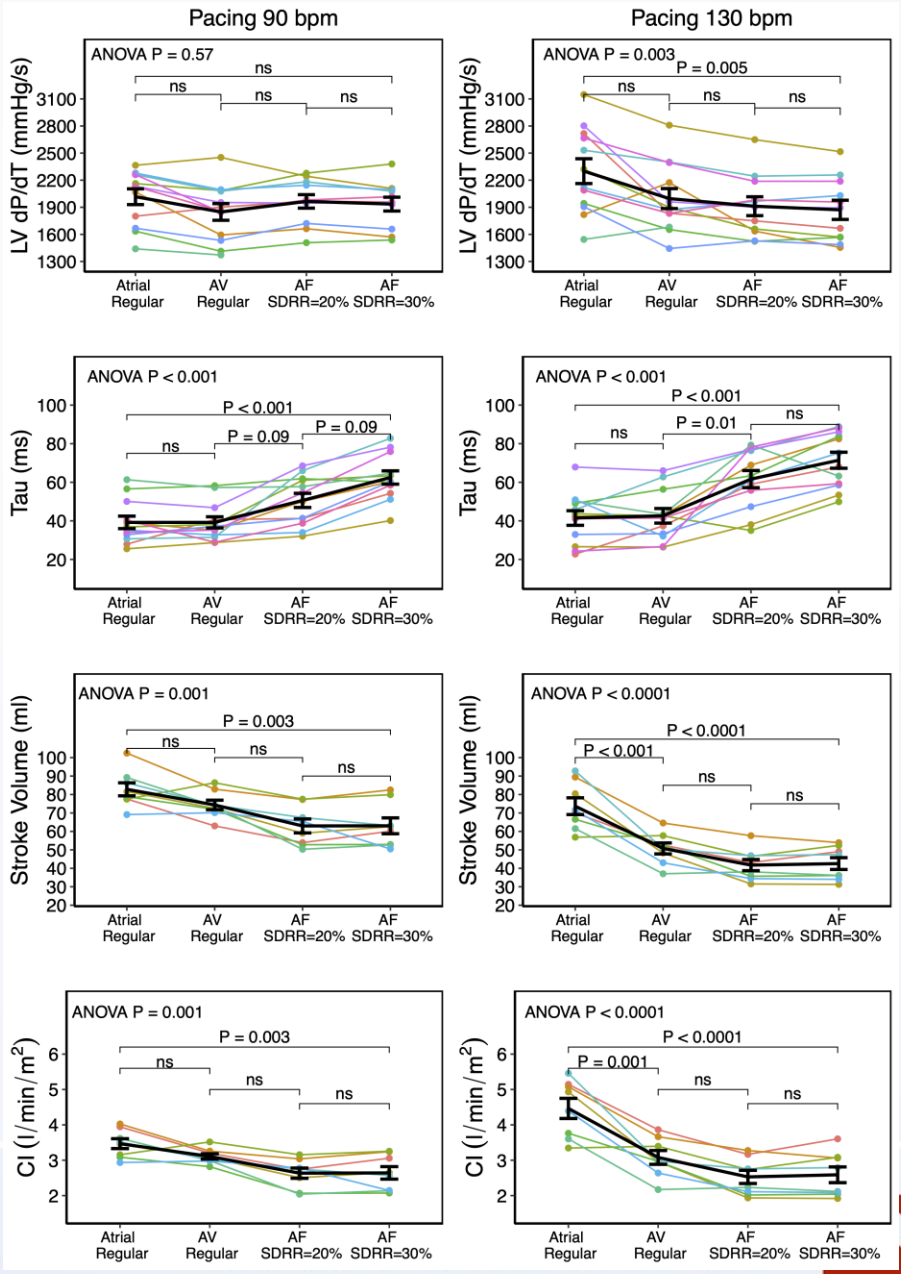
Results

		Relative Percent Difference			
		Atrial regular vs AV regular	AV regular vs AF 20% SD	AF 20% SD vs AF 30% SD	Atrial regular vs AF 20% SD
Pacing 90 bpm	SBP (mmHg)	-2.5**	-4.8*	-2.5*	-7.2***
	EDP (mmHg)	-2.1	28.9*	11.9	26.2*
	LAP (mmHg)	11.8	9.4	9.6	22.3
	dP/dT (mmHg/s)	-8.4*	3.1	-1.8	-5.6*
	Tau (ms)	0	29.1*	23.5***	29.1*
	SV (ml)	-10.2*	-15.3**	0	-24*
	CI (l/min/m2)	-10.3*	-15.2**	0.2	-24**
Pacing 130 bpm	SBP (mmHg)	-12.1**	-6*	-1.6	-17.4***
	EDP (mmHg)	8.7	30.3	10.8	41.6**
	LAP (mmHg)	36.6***	4.1	7.8	42.2*
	dP/dT (mmHg/s)	-13.2**	-6.9*	-2.7	-19.2***
	Tau (ms)	2.7	44.6**	15.9*	48.6**
	SV (ml)	-31.1**	-17.8**	2	-43.3***
	CI (l/min/m2)	-31**	-17.9**	2.4	-43.4***

AF = atrial fibrillation, AV = atrio-ventricular, significance level for comparisons between pacing modes within Pacing 90 bpm and Pacing 130 bpm group, respectively: * $P \leq 0.05$ ** $P \leq 0.01$ *** $P \leq 0.001$ by paired t-test with Holm's correction for repeated measurements

Results


Pacing 90 bpm
Pacing 130 bpm
ANOVA P = 0.16
ANOVA P = 0.003
P = 0.005
SBP (mmHg)
ANOVA P = 0.006
P = 0.02
ANOVA P = 0.002
P = 0.005
LVEDP (mmHg)
ANOVA P = 0.23
ANOVA P = 0.01
P = 0.009
LAP (mmHg)
ns
Atrial Regular
AV Regular
AF SDRR=20%
AF SDRR=30%


Pacing 90 bpm
Pacing 130 bpm
ANOVA P = 0.57
ANOVA P = 0.003
P = 0.005
LV dP/dT (mmHg/s)
ANOVA P < 0.001
P < 0.001
P = 0.09
P = 0.09
P = 0.01
Tau (ms)
ANOVA P = 0.001
P = 0.003
ANOVA P < 0.0001
P < 0.0001
P < 0.001
Stroke Volume (ml)
ANOVA P = 0.001
P = 0.003
ANOVA P < 0.0001
P < 0.0001
P = 0.001
CI (l/min/m²)
ns
Atrial Regular
AV Regular
AF SDRR=20%
AF SDRR=30%

Conclusion

- Simulated AF led to significant impairment of left ventricular systolic and diastolic function.
- Both loss of atrial contraction and heart rate irregularity significantly contributed to hemodynamic impairment.
- This effect was pronounced with increasing heart rate.

- Our findings strengthen the rationale for therapeutic strategies aiming at rhythm control and heart rate regularization in patients with AF.