Special Brief Communication

Effect of Interatrial Block on Left Atrial Function

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Abstract

Interatrial block produces prolonged P-waves due to conduction delay mainly in the Bachmann bundle, the most direct route from right to left atrium. It is prevalent in patients over age 60 with its main clinical significance its association with eventual atrial fibrillation and/or flutter. Having demonstrated a mean delay in the onset of active left ventricular filling of 37 msec, we defined the electromechanical abnormality further by measuring left atrial volume at key points in the atrial cycle to produce 10 measurements of left atrial function. Compared to the normal left atrium, interatrial block is correlated with a large, poorly contractile left atrium with a delayed and markedly reduced contribution to left ventricular filling and the kinetic energy with which atrial systole propels blood.

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Key Words

■ **Atrial function (interatrial block)** ■ **Electrocardiography** ■ **Atrial fibrillation** ■ **Atrial flutter**

INTRODUCTION

Interatrial block, attributed to conduction delay mainly in the Bachmann muscular bundle[1] (interatrial bundle), produces prolonged P-waves (≥110 msec). Although it is remarkably prevalent in a general hospital population, especially in patients over age 60, it is widely unappreciated and not identified by computer electrocardiography interpretation systems. Its major importance has been as a predictor and correlate of atrial fibrillation and atrial flutter. However, interatrial block has functional as well as electrical significance because the right atrium is immediately depolarized by the sinus impulse, and the delay is in left atrial activation. We were able to demonstrate a delay in the onset of active left ventricular filling as compared to control patients who, like the population with interatrial block, had left atrial enlargement but without interatrial block[2]: subtracting the electromechanical interval of the right atrium (normal) from that of the left atrium (prolonged) yielded a 37 msec mean difference at a significance level of $p < 0.001$. The new question to be addressed was, apart from the electrical delay, what is the mechanical status of the left atrium during interatrial block ?

METHODS

Measurements and calculations in a new series of 12 consecutively acquired patients with interatrial block were compared with normal values to highlight the differences. Volumetric measurements were made by echo-Doppler studies, utilizing specifically the apical 2- and 4-chamber scan planes because they are orthogonal. Atrial reservoir volume (atrioventricular valve closure to atrioventricular valve opening) and left atrial (LA) contraction volume (atrial systole to ventricular valve closure) and atrial volume at atrial contraction (at the P-wave) were determined. Conduit function (atrioventricular valve opening to onset of atrial systole) was not measured because this requires additional mea-

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surement of left ventricular (LV) stroke volume.

Calculations: Calculation of each LA volume was by the area-length formula:

$$\text{Volume} = \frac{8 \times \text{A4ch} \times \text{A2ch}}{3\pi \times \text{common LA diameter}}$$

A4ch = LA area in 4-chamber plane

A2ch = LA area in 2-chamber plane

Functional measurements: Determinations included LA_{max} (maximal LA volume just before mitral valve opening); LA_{min} (minimal LA volume just before left ventricular systole and mitral closure) and LA volume at atrial systole (by timing with the P-wave of the electrocardiogram). **Table 1** summarizes these measurements and the various functions derived from them including LA fractional ejection; LA stroke volume (active emptying); LA active emptying fraction; LA passive emptying; LA total emptying; and LA kinetic energy in kilodyne-centimeters, which also requires measuring the maximum Doppler A wave velocity.

Table 1 Volumetrics

Left atrial (LA)	Measurement points/calculations
LA_{max}	Mitral opening
LA_{min}	Mitral closure
LA reservoir	$LA_{max}-LA_{min}$
LA fractional ejection	LA reservoir $-L_{max}$
LA at atrial systole	P-wave
LA stroke volume (active emptying)	LA at P-wave $-LA_{min}$
LA active emptying fraction	LA stroke volume/LA at P-wave
LA passive emptying	$LA_{max}-$LA at P-wave
LA total emptying	LA active + passive emptying
LA kinetic energy	0.5×LA stroke volume×1.06 ×Doppler A velocity

RESULTS

Table 2 summarizes the mean results for all measurements during interatrial block compared with normal means in the order of magnitude of effect expressed as percent difference (%Δ). The following were increased: LA_{max}; LA_{min}; LA volume at the P-wave. The following were reduced: LA active emptying = LA stroke volume; LA passive emptying; LA reservoir volume; total emptying volume; LA fractional ejection; LA active emptying fraction; LA kinetic energy. It is evident from **Table 2** that there are substantial differences from normal in every measurement. (Statistical tests have not been applied because the differences are quite obvious and the normal patients were not matched.)

DISCUSSION

Table 2 shows the degree of effect in percent change, the largest being at LA minimal volume which is almost three times greater in patients with interatrial block: a 165% increase. The volume at atrial systole (P-wave) is increased but twice the amount over the normal series. The only other increased variable is LA maximum volume which was increased 27%. These indicate an enlarged, overfilled left atrium. All the other variables were reduced substantially, reflecting overall poor emptying of the left atrium. This was due to fundamental contractile impairment clearly reflected in LA

Table 2 Indices of left atrial function (in declining order of changes)

Normals (means)	Left atrial (LA)	Interatrial block	%Δ
17.0 m*l*	Minimum volume	45.0 m*l*	+165
25.3 m*l*	LA volume at P-wave	51.0 m*l*	+102
4.24 m/sec	T wave mitral peak A velocity	0.53 m/sec	−88
19.0 m*l*	Passive emptying volume	5.0 m*l*	−74
0.62	Fractional emptying	0.20	−68
0.32	Active emptying fraction	0.12	−63
27.0 m*l*	Reservoir volume	11.5 m*l*	−61
27.0 m*l*	Total emptying volume	10.9 m*l*	−60
17.0 kDYN-cm	Kinetic energy	10.0 kDYN-cm	−41
44.0 m*l*	Maximum volume	56.0 m*l*	+27
8.0 m*l*	Active emptying volume ("stroke volume")	5.9 m*l*	−26

kDYN-cm = kilodyne-centimeters.

kinetic energy which was reduced by 41% because of both of its components: reduced LA stroke volume (active emptying volume) and reduced transmitral A wave peak velocity. The A peak velocity was more affected (88% reduction) in contrast to LA stroke volume which was reduced by 26%.

CONCLUSIONS

It is clear that interatrial block, virtually always in an enlarged LA, represents an atrium which is both distended and poorly contractile. Even its passive emptying volume is relatively small so it contributes less to ventricular filling during diastole.

References

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