Changes in Regional Left Atrial Function with Aging: Evaluation by Doppler Tissue Imaging

L. Thomas¹, K. Levett¹, A. Boyd¹, D. Y. C. Leung², N. B. Schiller³ and D. L. Ross¹

¹Department of Cardiology, Westmead Hospital, Sydney, Australia; ²Department of Cardiology, Liverpool Hospital, Sydney, Australia and ³Adult Echocardiography Laboratory, Moffitt Hospital, UCSF, California, U.S.A.

Aims: This study applies pulsed wave Doppler tissue imaging and colour Doppler tissue imaging to study changes in atrial function with ageing. We tested the following hypotheses: (1) pulsed wave Doppler tissue imaging can detect global changes of left atrial function associated with ageing similar to standard echocardiographic methods, (2) colour Doppler tissue imaging can reproducibly detect regional changes in atrial function (wall motion) of the normal young and normal aging atrium.

Methods and Result: We studied 92 healthy subjects, divided into Group B (≥50 years) and Group A (<50 years). As a reference standard the conventional measures of atrial function were determined: peak mitral A wave velocity, A wave velocity time integral, atrial emptying fraction and atrial ejection force. Pulsed wave Doppler tissue imaging estimated atrial contraction velocity (A' velocity) in late diastolic and segmental atrial contraction was determined by colour Doppler tissue imaging.

A' velocities were significantly higher in Group B vs Group A (9·8 ± 1·8 vs 8·5 ± 1·5 cm/s; P=0·0005). A' velocity correlated with atrial fraction (r=0·28; P=0·007) and atrial ejection force (r=0·21; P=0·04). Age correlated significantly with atrial ejection force (r=0·47; P=0·0001), atrial fraction (r=0·61; P=0·0001) and A' velocity (r=0·4; P=0·0002). Longitudinal segmental atrial contraction using colour Doppler tissue imaging showed an annular to superior segment decremental gradient with contraction velocities higher in Group B vs Group A.

Conclusion: Pulsed wave Doppler tissue imaging and colour Doppler tissue imaging are reproducible and readily obtained parameters that provide unique data about global and segmental atrial contraction. In this study, changes in atrial contraction with aging were consistent with increased atrial contribution to filling accomplished by augmented atrial contractility.

Key Words: Echocardiography; atrial function; segmental atrial contraction; Doppler Tissue Imaging; ageing.

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The left atrium serves as both a reservoir and a conduit for passage of blood from the pulmonary veins to the left ventricle and as a contractile chamber that augments left ventricular filling. Vortical flow has been observed in the atrium during systole and diastolic diastasis[1]. Previous studies indicate that the atria contribute up to 30% of left ventricular filling and cardiac output[2] and is particularly important in the setting of impaired left ventricular function.

Changes in the behaviour of segmental atrial function with normal ageing, have not, to our knowledge, been studied, largely because there is no direct non-invasive method available. Traditionally, blood flow velocity during atrial contraction, the peak mitral inflow A wave velocity[3,4] its velocity time integral and atrial emptying fraction[3,4] have been used as surrogate markers of atrial function. Atrial ejection force[4,5] based on classic Newtonian principles and derived as the force exerted by the left atrium to accelerate blood into the left ventricle, has also been used as a marker of atrial function.

Doppler tissue imaging is a recently developed technique for the quantitation of myocardial contraction and relaxation in the left ventricle using low velocity
pulsed wave Doppler interrogation of the myocardium\textsuperscript{[6,7]}. Pulsed wave Doppler tissue imaging has high temporal resolution but requires real time data acquisition. Colour Doppler tissue imaging measures modal velocity and has less temporal resolution than pulsed wave Doppler tissue imaging\textsuperscript{[8–10]}. Colour Doppler tissue imaging, however, enables simultaneous acquisition of myocardial velocities in multiple segments of the myocardium in the same imaging view with measurements performed off line.

Based on these considerations, we hypothesized that (1) pulsed wave Doppler tissue imaging could be applied to reproducibly quantitate late diastolic atrial contraction velocity ($A'$ velocity), (2) colour Doppler tissue imaging could evaluate segmental atrial contraction, (3) $A'$ velocity would correlate with standard parameters of atrial function including atrial emptying fraction and atrial ejection force and (4) $A'$ velocity would be altered with increasing age as a result of the normal decline in left ventricular relaxation.

**Methods**

The study was approved by the Committee for Human Research at Westmead and Liverpool Hospitals. A total of 92 healthy subjects (30 males, 62 females) were enrolled; 63 subjects were recruited from Westmead Hospital and 29 subjects from Liverpool Hospital. None of the enrolled subjects had a history of ischaemic heart disease or significant valvular abnormalities, peripheral vascular disease, cerebrovascular disease, hypertension or diabetes. None of the 92 subjects was receiving cardioactive medications. Subjects were divided into two groups based on age: Group A: <50 years (range 17–49 years; mean age 32 years; n=47) and Group B: ≥50 years (range 50–86 years; mean age 63 years; n=45).

**Standard Transthoracic Echocardiography**

Doppler M mode and two-dimensional echocardiography were performed according to established clinical laboratory practice using two commercially available systems (System 1: Agilent/Philips Sonos 5500, System 2: General Electric/Vingmed System 5) equipped with 3·5 MHz variable frequency harmonic phased array transducers. Left atrial end systolic volume (the maximum left atrial volume in ventricular systole) and left atrial end diastolic volume, (the minimum left atrial volume in ventricular diastole) were calculated from apical four and apical two chamber zoomed views of the left atrium, using the biplane method of discs\textsuperscript{[11,12]}. Left atrial stroke volume was estimated as the difference between left atrial end systolic volume and left atrial end diastolic volume. Left ventricular ejection fraction was also measured in all patients by the biplane method of discs from the apical two-chamber and four-chamber views\textsuperscript{[13]}. Mitral inflow velocity was obtained by pulsed wave Doppler sampling at the tips of the mitral leaflets from the apical four-chamber at a sweep speed of 100 mm/s. Peak velocity of atrial contraction in late diastole ($A$ wave velocity) was measured\textsuperscript{[3,4]}. The velocity time integral of the mitral $A$ wave was measured and the atrial emptying fraction was estimated as $A$ velocity time integral divided by the total velocity time integral of mitral inflow\textsuperscript{[3,4]}.

Pulmonary vein flow velocities were recorded from the apical four-chamber view with the sample volume placed 1–2 cms into the right upper pulmonary vein. Colour flow Doppler was used to align the Doppler cursor parallel to the pulmonary venous flow. Filter and gain settings were adjusted to obtain the least amount of noise for all recordings. Pulsed wave Doppler signals were obtained at a sweep speed of 100 mm/s. Peak velocities, velocity time integral and duration of atrial reversed flow were measured\textsuperscript{[14]}.

Atrial ejection force is defined as the product of the mass and acceleration of blood from the left atrium\textsuperscript{[5]} and was estimated using the equation Atrial ejection force=\textit{mass} × acceleration. Substituting for mass and acceleration, atrial ejection force=$0·5 \times \rho \times (\text{density of blood}=1·06 \, \text{g/cm}^3) \times \text{mitral orifice area} \times (\text{peak A velocity})^2$ as previously described\textsuperscript{[4,5]}.

**Pulsed Wave Doppler Tissue Imaging**

Peak velocity in late diastole secondary to atrial contraction ($A'$) was measured in all patients using pulsed wave Doppler tissue imaging at a sweep speed of 100 mm/s. The pulsed wave Doppler sample volume (sample volume size 4 mm) was placed on the atrial side of the mitral annulus at the basal interatrial septum in the apical four-chamber view (Fig. 1) and the velocity range was set at 15 to −15 cm/s. Special attention was made to align the Doppler beam to the interatrial septum to optimize Doppler measurements. Measurements were obtained during end expiration to eliminate respiratory variation and an average of three beats measured. Digital images were obtained and stored on magneto optical discs and reviewed later on a stand alone offline measuring system (ECHO PAC for System 2 and En Concert for the System 1).

**Colour Doppler Tissue Imaging**

Colour Doppler tissue imaging was performed in a subgroup of 63 patients as colour Doppler tissue imaging was not available on System 1. Segmental atrial contraction velocity was measured offline from colour Doppler tissue images of the atrium obtained in the apical four and two chamber views. Real time colour Doppler was superimposed on grey scale with a frame rate ≥90 fps. Special attention was paid to the Doppler velocity range to avoid aliasing. From the apical four-
chamber view, measurements were made from five segments of the left atrium (1: septal annular segment; 2: septal mid segment; 3: superior segment; 4: lateral mid segment; 5: lateral annular segment) and three segments of the right atrium (6: lateral annular segment; 7: lateral mid RA segment; 8: superior RA segment) (Fig. 2). From the apical two chamber view, measurements were made from five segments of the left atrium (9: posterior annular segment; 10: posterior mid segment; 11: superior segment; 12: anterior mid segment; 13: anterior annular segment) (Fig. 2). Nine × nine pixel sampling was used and a tissue velocity profile throughout the cardiac cycle was displayed in each sample location (Fig. 3). The mean peak velocity of atrial contraction was measured in each segment as an average of two beats.

We imaged the left atrium using standard apical four- and two-chamber views and also as zoomed up atrial views. Furthermore, as the atrium is thin walled, we measured segmental velocities using the traditional 9 × 9 pixel size described in the literature as well as using a 1 × 1 pixel size.

**Left Ventricular Diastolic Function**

The descriptors of left ventricular diastolic function were measured using standard echocardiographic parameters. These included peak E velocity, peak A velocity, E/A ratio and deceleration time from transmitral inflow pattern measured by pulsed wave Doppler, with the sample volume placed at the leaflet tips. The peak velocity of mitral annular ascent in early diastole (E’ velocity) coinciding with left ventricular relaxation was measured using pulsed wave Doppler tissue imaging as an average from three beats with the sample volume placed on the atrial side of the septal annulus at a sweep speed of 100 mm/s.

**Observer Agreement**

In 10 randomly selected studies from each group, two readers independently estimated peak A’ velocity using pulsed wave Doppler tissue imaging and segmental A’ velocity using colour Doppler tissue imaging as offline measurements. The peak A velocity, A velocity time integral and atrial fraction were also estimated by two readers. One observer examined the same 20 studies at a separate time to determine intra-observer agreement.

**Analysis**

All values are expressed as a mean ± SD unless otherwise stated. Differences between groups were examined by two sample Student’s t-test and by repeated measures ANOVA. Linear regression was used to examine the relationship between age and peak A velocity, atrial fraction, atrial ejection force, A’ velocity, E velocity and E’ velocity. Spearman rank correlation was used to examine the relationship between A’ velocity and atrial fraction and atrial ejection force. Multiple regression analysis with forward stepwise variable selection was performed to examine the relationships between A’,
atrial fraction, atrial ejection force and various factors including age, heart rate, E'/p9 velocity, left atrial end systolic volume and left atrium stroke volume. Bland Altman analysis[15] was used to assess reproducibility within and between observers. Data were analysed using Stat View Student (version 4.0) and SPSS for Windows (version 10.0).

**Results**

Table 1 summarizes the demographic and echocardiographic variables of 92 subjects divided into two groups according to age. Traditional parameters for atrial function, namely the A velocity, A wave velocity time integral, atrial fraction and atrial ejection force were significantly higher in Group B than in Group A (Table 1). No significant differences were noted between groups in maximal and minimum left atrium volumes and in measures of pulmonary venous flow A wave reversal.

### A' Velocity and Atrial Function with Ageing

The A' velocities were significantly higher in Group B than in Group A (9.8±1.5 vs 8.5±1.2; t=3.6; P=0.0005). There was a positive correlation by Spearman Rank Correlation between A' velocity and atrial fraction (r=0.28; P=0.007) and A' velocity and atrial ejection force (r=0.4; P=0.0002). The atrial ejection force (r=0.47; P=0.0001), atrial fraction (r=0.61; P=0.0001) and A' velocity (r=0.4; P=0.0002) correlated with age (Fig. 4). When age, gender, heart rate, left atrial end systolic volume, left atrial stroke volume, A' velocity, E' velocity were entered into a multiple regression model only age, left atrial stroke volume and heart rate were significant independent predictors of the atrial ejection force (atrial ejection force=0.31(age)+4.5 (left atrial stroke volume)+0.27 (heart rate)—25; r=0.63; P<0.0001). Age, heart rate and E' velocity were significant independent predictors of the atrial fraction (atrial fraction=11.1+0.3 (age)+0.34 (heart rate)—0.82 (E' vel); r=0.73; P<0.0001). When age, gender, heart rate, left atrial end systolic volume, left atrial stroke volume and E', were entered into a multiple regression model only age was a significant independent predictor of A' (r=0.41; P<0.006). Thus in all three instances, age was
Atrial ejection force vs Age: y=0.29x+4.2; r=0.47; p=0.0001

Atrial fraction vs Age: y=0.37x+23.2; r=0.61; p=0.0001

A’ velocity vs Age: y=0.39x+7.3; r=0.38; p=0.0002

**Figure 4.** Regression plot of correlation between atrial ejection force and age (r=0.47; P=0.0001), atrial fraction and age (r=0.61; P=0.0001) and A’ velocity and age (r=0.38; P=0.0002) in the study population of 92 subjects. A’=atrial contraction in late diastole.
the common independent variable that significantly influenced $A'$, atrial fraction and atrial ejection force.

**Colour Doppler Tissue Imaging Segmental Velocities of Left and Right Atrium**

A total of 13 segments were analysed in 63 patients imaged with System 2. Atrial contraction velocities were increased in all segments in Group B in the apical four and two chamber views (Table 2) but failed to reach statistical significance in each individual segment. Repeated measures ANOVA detected a statistically significant annular to superior gradient with velocities in the annular segments being highest, in addition to an age effect. A significant difference was noted in segmental velocities between Group A and Group B ($P=0.001$). There were no statistically significant two- or three-way interactions between position, gender or age group. Differences in gender for atrial segmental velocities were examined but demonstrated no significant velocity differences between males and females (Table 3).

We also compared the septal and lateral velocities in the annular segments from the apical four chamber view for all 63 subjects and no significant difference was noted between these two segments (septal annular vs lateral annular velocity: $6.9 \pm 1.8$ vs $7.1 \pm 2.3$ cm/s). Subgroup analysis of group A and B for annular segmental velocities showed no significant difference between the septal and lateral annular segments.

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**Table 2. Segmental colour Doppler tissue imaging velocities of atrial contraction from apical four and two chamber.**

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Apical four chamber</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral annular RA (cm/s)</td>
<td>$-8.2 \pm 2.3$</td>
<td>$-9.6 \pm 2.3$</td>
<td>0.02</td>
</tr>
<tr>
<td>Lateral mid RA (cm/s)</td>
<td>$-4.6 \pm 1.8$</td>
<td>$-5.3 \pm 1.1$</td>
<td>0.18</td>
</tr>
<tr>
<td>Superior RA (cm/s)</td>
<td>$-1.3 \pm 1.3$</td>
<td>$-1.6 \pm 1.3$</td>
<td>0.23</td>
</tr>
<tr>
<td>Septal annular (cm/s)</td>
<td>$-6.6 \pm 1.6$</td>
<td>$-7.2 \pm 1.3$</td>
<td>0.09</td>
</tr>
<tr>
<td>Septal mid (cm/s)</td>
<td>$-4.6 \pm 1.6$</td>
<td>$-5.0 \pm 1.6$</td>
<td>0.25</td>
</tr>
<tr>
<td>Superior LA (cm/s)</td>
<td>$-1.1 \pm 0.7$</td>
<td>$-1.4 \pm 0.8$</td>
<td>0.05</td>
</tr>
<tr>
<td>Lateral mid LA (cm/s)</td>
<td>$-5.9 \pm 1.9$</td>
<td>$-6.8 \pm 1.9$</td>
<td>0.06</td>
</tr>
<tr>
<td>Lateral annular LA (cm/s)</td>
<td>$-6.4 \pm 2.2$</td>
<td>$-7.7 \pm 2.2$</td>
<td>0.02</td>
</tr>
</tbody>
</table>

| **Apical two chamber**  |                  |                  |           |
| Posterior annular LA (cm/s)| $-6.9 \pm 1.8$ | $-8.4 \pm 1.7$  | 0.02      |
| Posterior mid LA (cm/s)  | $-4.5 \pm 1.9$  | $-5.0 \pm 1.6$  | 0.32      |
| Superior LA (cm/s)       | $-1.3 \pm 1.1$  | $-1.6 \pm 1.0$  | 0.33      |
| Anterior mid LA (cm/s)   | $-5.6 \pm 2.3$  | $-6.6 \pm 2.1$  | 0.07      |
| Anterior annular LA (cm/s)| $-6.4 \pm 2.0$ | $-6.9 \pm 2.0$  | 0.31      |

The values in this table have ‘−’ if the movement was away from the transducer and ‘+’ if movement was towards the transducer. LA=left atrium, RA=right atrium.

**Table 3. Segmental colour Doppler tissue imaging velocities of atrial contraction from apical four and two chamber for males and females.**

<table>
<thead>
<tr>
<th></th>
<th>Females (n=40)</th>
<th>Males (n=23)</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Apical four chamber</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral annular RA (cm/s)</td>
<td>$-9.1 \pm 2.2$</td>
<td>$-8.5 \pm 2.7$</td>
<td>0.35</td>
</tr>
<tr>
<td>Lateral mid RA (cm/s)</td>
<td>$-4.8 \pm 2.1$</td>
<td>$-5.2 \pm 2.5$</td>
<td>0.53</td>
</tr>
<tr>
<td>Superior RA (cm/s)</td>
<td>$-1.4 \pm 0.8$</td>
<td>$-1.6 \pm 1.3$</td>
<td>0.29</td>
</tr>
<tr>
<td>Septal annular (cm/s)</td>
<td>$-6.8 \pm 1.4$</td>
<td>$-7.2 \pm 1.6$</td>
<td>0.35</td>
</tr>
<tr>
<td>Septal mid (cm/s)</td>
<td>$-4.7 \pm 1.6$</td>
<td>$-5.0 \pm 1.5$</td>
<td>0.46</td>
</tr>
<tr>
<td>Superior LA (cm/s)</td>
<td>$-1.2 \pm 0.8$</td>
<td>$-1.3 \pm 0.8$</td>
<td>0.73</td>
</tr>
<tr>
<td>Lateral mid LA (cm/s)</td>
<td>$-6.4 \pm 2.0$</td>
<td>$-6.5 \pm 1.8$</td>
<td>0.82</td>
</tr>
<tr>
<td>Lateral annular LA (cm/s)</td>
<td>$-7.3 \pm 2.5$</td>
<td>$-6.7 \pm 1.9$</td>
<td>0.30</td>
</tr>
</tbody>
</table>

| **Apical two chamber**  |                |              |           |
| Posterior annular LA (cm/s)| $-7.7 \pm 1.8$ | $-7.6 \pm 2.0$ | 0.82      |
| Posterior mid LA (cm/s)  | $-4.6 \pm 1.5$ | $-4.9 \pm 2.1$ | 0.5       |
| Superior LA (cm/s)       | $-1.3 \pm 0.8$ | $-1.8 \pm 1.3$ | 0.07      |
| Anterior mid LA (cm/s)   | $-6.1 \pm 2.1$ | $-6.1 \pm 2.5$ | 0.93      |
| Anterior annular LA (cm/s)| $-6.5 \pm 2.0$ | $-7.0 \pm 2.0$ | 0.36      |

The values in this table have ‘−’ if the movement was away from the transducer and ‘+’ if movement was towards the transducer. LA=left atrium, RA=right atrium.
Comparison of 9 × 9 pixel vs 1 × 1 pixel in estimating segmental atrial velocities, demonstrated uniformly increased A' velocities in all segments with 1 × 1 pixel measurement but failed to reach significance consistently for each individual atrial segment. Hence the final analysis was performed using the standard 9 × 9 pixel size.

Left Ventricular Diastolic Function

Left ventricular diastolic function is known to alter with ageing. In Group A, E/A ratio was <1 in 247 subjects vs 26/45 subjects in Group B (58%) indicating decreased left ventricular relaxation with ageing. We further measured the E' velocity and this was significantly higher in Group A vs Group B (mean ± SD=10.3 ± 2.6 vs 6.5 ± 1.6; t=8.6; P=0.0001). An inverse correlation was noted between age and E' velocity (r= −0.73; P=0.0001).

Observer Variability

Ten subjects in each group were randomly selected for inter-observer and intra-observer variability. Peak A velocity, A velocity time integral, atrial fraction, A' velocity and atrial segmental velocities were re-measured by the same observer and by a second independent observer from the digital data using an offline system. Bland Altman analysis for segmental colour Doppler tissue imaging demonstrated an intraobserver mean difference of 0.02 cm/s (95% CI 0.8, −1.2 cm/s). The inter-observer variability showed a mean difference of 0.02 cm/s (95% CI 0.66, −0.62 cm/s). Bland Altman analysis for A' showed an interobserver mean difference of 0.07 cm/s (95% CI 0.61, −0.47 cm/s). The intra-observer variability showed a mean difference of 0.06 cm/s (95% CI 0.42, −0.3 cm/s). Bland Altman analysis showed an interobserver mean difference of 0.1 cm/s (95% CI 3.3, −3.1 cm/s) for peak A velocity, mean difference of 0.13 cm (95% CI 0.93, −0.67 cm) for A velocity time integral and a mean difference of 0.3% (95% CI 3.1, −2.5%) for atrial fraction. The intra-observer variability showed a mean difference of 2 cm/s (95% CI 8, −4 cm/s) for peak A velocity, mean difference of 0.06 cm (95% CI 3.2, −3.1 cm/s) for A velocity time integral and a mean difference of 3.3% (95% CI 5.9, −3.3) for atrial fraction.

Discussion

We have demonstrated that pulsed wave Doppler tissue imaging can be used to estimate global atrial contraction and that colour Doppler tissue imaging can be used to estimate segmental atrial contraction in normal subjects in sinus rhythm. A' velocity was noted to increase with age with a significant difference between groups. The peak mitral A wave velocity, mitral A wave velocity time integral, atrial fraction and atrial ejection force, our reference standards, were, as expected, significantly increased with age. A' velocity correlated with atrial fraction and atrial ejection force. The peak mitral E and mitral annular (Doppler tissue imaging) E' velocities were decreased significantly with age. No significant changes were noted in left atrium size or parameters of pulmonary atrial flow reversal with ageing.

Relevance of A' Velocity and Ageing

While the peak A velocity, A velocity time integral and atrial fraction have been noted to be increased with age, they are in one sense only surrogate markers of atrial function representing blood flow during atrial contraction. A' velocity is a measure of intrinsic atrial contraction that increased with age[9]. Doppler tissue imaging of mitral annular motion has been extensively studied to evaluate left ventricular diastolic function[22]. Ageing is associated with a decrease in systolic velocity[23,24] and also early diastolic velocity[23,24]. Previous studies[24,25] showed a decrease in E' velocity with an increase in A' velocity with ageing, a result similar to that demonstrated in our study.

The Physiology of Ageing

Previous studies have demonstrated age related slowing in left ventricular relaxation[16,17] with E/A reversal on transmirtal Doppler inflow recordings[18,19]. More recent studies measuring AV plane displacement using M mode have confirmed these observations[20,21]. Doppler tissue imaging has recently come to the forefront as a preload independent measure to evaluate left ventricular diastolic function[22]. Ageing is associated with a decrease in systolic velocity[23,24] and also early diastolic velocity[23,24]. Previous studies[24,25] showed a decrease in E' velocity with an increase in A' velocity with ageing, a result similar to that demonstrated in our study.
A’ velocity is relatively easy to measure and is reproducible as demonstrated by inter- and intra-observer analysis. Further, age is the common independent predictor of A’ velocity, atrial fraction and atrial ejection force in multiple regression analysis. Thus, increased intrinsic atrial contraction results in the increase in A’ seen with aging.

**Segmental Atrial Contraction**

To our knowledge, comprehensive segmental contraction of the body of the left atrium has not been studied. Earlier work has examined differences between contraction velocity of the left atrial appendage and body and differences in blood flow velocities within the atrium. Colour Doppler tissue imaging has recently been used for segmental analysis of the left ventricle but no previous studies have evaluated segmental atrial contraction. Doppler tissue imaging is angle dependent and therefore the peak velocity obtained would depend on the angle between the interrogating Doppler beam and the axis of movement of the atrial wall.

An annular to superior segment gradient was noted; thus atrium adjacent to the annulus has the fastest movement. The superior segment of the atrium is relatively fixed and contributes insignificantly to longitudinal contraction. Additive translation from cardiac motion may contribute to the increased velocities in the atrial segments adjacent to the annulus. Segmental atrial velocities were uniformly higher in Group B demonstrating that longitudinal atrial contraction velocity increases with age.

Determination of segmental atrial contraction velocities may find applicability in diseased states particularly atrial fibrillation and its current treatment modalities. Studies of regional atrial function may be useful in assessing the impact of new surgical and catheter ablation methods to cure atrial fibrillation. These techniques make lines of block within the atria to prevent multiple re-entry circuits. Colour Doppler tissue imaging may be useful in these situations if it is sensitive enough to identify these lines of block as areas of decreased atrial segmental contraction. Future studies would be required to evaluate its use to predict the occurrence of atrial thrombi.

While Doppler tissue imaging estimates regional myocardial contractility, the point velocity of the specific left atrial region does not differentiate between active contraction and passive motion related to cardiac translation. The recent development of myocardial strain and strain rate estimation, that calculates spatial differences in tissue velocities between neighbouring myocardial regions may obviate some of these problems.

**Limitations**

All subjects were recruited on the basis of a history and normal echocardiogram. Exercise stress tests were not performed to evaluate the population more specifically for exercise capacity.

All subjects were in sinus rhythm. As the A’ wave secondary to atrial contraction is absent in atrial fibrillation, its application to the population as a whole is limited.

The reference standards used for comparison were traditional echocardiographic parameters. Invasive tests such as cardiac catheterization in normal subjects was not considered feasible.

We studied A’ velocity in a cohort of normal subjects in the absence of segmental left ventricular wall motion abnormalities. Decreased left ventricular diastolic compliance or systolic wall motion abnormalities may alter atrial contraction that is estimated from the atrial side of the septal annulus. Its application to cases with a basal septal left ventricular wall motion abnormality is yet to be evaluated.

**Conclusion**

The velocity of atrial contraction (A’ velocity) and segmental velocities (colour Doppler tissue imaging) are reproducibly and predictably increased with ageing. Our data also show that atrial contraction velocities vary within anatomical segments with an annular to superior gradient. Age-related increases in atrial contraction are probably compensatory to altered left ventricular relaxation seen with ageing.

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**References**


