Color Doppler evaluation of aortic dissection

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ABSTRACT Color Doppler studies were performed in 16 adult patients with proven DeBakey type I and III aortic dissection. Simultaneous opacification of both aortic lumina with oppositely directed flow was noted by color Doppler in at least one aortic segment in 14 of 16 patients (12 type I, two type III). In two patients (one type I, one type III), flow was seen in one lumen only, with clot demonstrated in the other lumen in one of them. Of 12 patients in whom communication between two aortic dissection channels was shown by angiography/surgery, color Doppler correctly identified them in nine patients (four ascending aorta, two aortic arch, and three descending aorta), either by direct visualization of flow moving from one lumen into the other (six patients) or indirectly by analyzing differences in timing of opacification of the two lumina and flow direction (three patients). Also, color Doppler correctly diagnosed aortic regurgitation as severe (aortic regurgitation jet occupying more than 75% of left ventricular outflow) in three patients and moderate in four patients. Color Doppler provides comprehensive evaluation of flow dynamics in aortic dissection.


PROGNOSIS of patients with aortic dissection is determined by several factors: duration of dissection at the time of diagnosis, location of intimal tear, site and extent of the dissection, presence or absence of blood flow in the false lumen, presence of pericardial effusion and tamponade, and presence and severity of aortic regurgitation.1–5 Therefore, since the survival rate and consequent therapeutic approach of patients with aortic dissection is influenced by both anatomic and flow conditions, an easy, repeatable technique capable of assessing this lesion noninvasively would be of great clinical usefulness.

An accurate morphologic evaluation of the dissecting process is obtainable with different cardiac imaging techniques such as cineangiography,6–8 computed tomography,9–11 magnetic resonance imaging, and two-dimensional echocardiography.12–15 Among these imaging techniques, cineangiography is the only one that also provides data on blood flow conditions in both true and false lumina; however, because of its invasive nature and the need to inject a certain amount of contrast material during fluoroscopy, it is not suitable for serial evaluation of patients with dissection. Two-dimensional Doppler color flow mapping (color Doppler)16–20 is a recently developed ultrasound technique that superimposes intracavitary flow patterns on real-time two-dimensional echocardiographic images. Because of this capability of simultaneous anatomy and flow imaging and the ease with which serial examinations can be performed even at the bedside, this new imaging system has the potential of becoming an ideal tool for the diagnosis and evaluation of patients with aortic dissection. In this study we discuss the color Doppler findings in 16 patients with aortic dissection proved by angiography.

Materials and methods

Sixteen patients (10 men, six women) formed the study population. Their ages ranged from 28 to 76 years (mean 49, table 1). Five patients had hypertensive heart disease; five patients had clinical evidence of Marfan’s syndrome and one of them, from previous two-dimensional echocardiographic studies, was known to have a huge aneurysm of the ascending aorta; six patients had atherosclerotic heart disease. Dissection was acute in six cases (observation made within 2 weeks of the onset of the clinical picture) and chronic in the remaining. According to DeBakey’s classification, 13 patients had type I dissection (beginning in the ascending aorta and extending for a variable distance into the descending portion), whereas the remaining three had type III dissection (originating distal to the arch vessels and extending into the descending aorta). None of the patients had type II dissection. Four of six patients with acute dissection underwent surgery; one of them was restudied 1 month after operation.

A control group of 10 patients with dilated aorta and no dissection were also studied by color Doppler (table 2). Two-dimensional echocardiography. Each patient underwent conventional two-dimensional echocardiographic examination before undergoing Doppler color flow mapping. Echo-
TABLE 1
Two-dimensional echocardiographic and color Doppler findings in patients with aortic dissection

<table>
<thead>
<tr>
<th>Location, age, sex</th>
<th>Symptoms/etiology</th>
<th>Positive 2D echo&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Bidirectional flow</th>
<th>Site of communication</th>
<th>No flow in one lumen</th>
<th>AR severity</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeBakey type I (13)</td>
<td>Asymptomatic (2)</td>
<td>13</td>
<td>AA (3)</td>
<td>1–3 cm above aortic valve (4)</td>
<td>1</td>
<td>4–5/5 (3)</td>
<td>Surgery (10)</td>
</tr>
<tr>
<td>Age 28–70 yr (mean 47)</td>
<td>Chest pain (7)</td>
<td></td>
<td>Arch (5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8M, 5F</td>
<td>Back pain (2)</td>
<td></td>
<td>DTA/AB (4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unconscious (2)</td>
<td></td>
<td>Arch (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HHD (4)</td>
<td></td>
<td>DTA (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marfan’s (5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DeBakey type III (3)</td>
<td>Chest pain (2)</td>
<td>3</td>
<td>DTA/AB (2)</td>
<td>DTA (1)</td>
<td>1</td>
<td>3/5 (1)</td>
<td>No surgery (3)</td>
</tr>
<tr>
<td>Age 42–76 yr (mean 60)</td>
<td>Dyspnea (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>All alive</td>
</tr>
<tr>
<td>2M, 1F</td>
<td>ASHD (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HHD (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The numbers in parentheses represent number of patients.
AA = ascending aorta; AB = abdominal aorta; AR = aortic regurgitation; Arch = aortic arch; ASHD = atherosclerotic heart disease; DTA = descending thoracic aorta; HHD = hypertensive heart disease.
<sup>a</sup>Flaplike undulating motion of inner dissected wall or ≥ 15 mm widening of aortic wall.

Echocardiographic studies were performed with phased array systems: Toshiba SSH60, Hewlett-Packard 77020, or Aloka 880. In all cases, echocardiographic studies were performed with the patient in the supine, left lateral, and right lateral decubitus positions and with all the different approaches, including left and right parasternal, apical, abdominal, suprasternal, and right and left supra- and infracavicular transducer positions.<sup>21</sup>

**Color Doppler.** Color Doppler studies were performed in all patients with an Aloka 880 or Toshiba SSH65 color flow system. These systems are capable of displaying real-time intracardiac flow patterns in a color-coded format superimposed on

TABLE 2
Two-dimensional echocardiographic and color Doppler findings in patients with nondissected dilated aorta (n = 10)

<table>
<thead>
<tr>
<th>Etiology/sex/age</th>
<th>Location of dilatation</th>
<th>Maximum aortic lumen inner diameter (mm)&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Linear echo in lumen/≥15 mm widening of aortic wall</th>
<th>Bidirectional flow in late systole and diastole</th>
<th>AR severity&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Confirmation</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 M</td>
<td>AA</td>
<td>50, 70</td>
<td>Not seen</td>
<td>Not Seen</td>
<td>3/5</td>
<td>7 angio</td>
</tr>
<tr>
<td>3 F</td>
<td>n = 2</td>
<td>(22–31)</td>
<td></td>
<td></td>
<td>(n = 2)</td>
<td>3 surgery</td>
</tr>
<tr>
<td>Ages 25 to 74 yr (mean 59)</td>
<td>Arch + AA (n = 3)</td>
<td>Arch</td>
<td>Not seen</td>
<td>Arch (n = 1)</td>
<td>2/5</td>
<td>Interval between CD and angiography was less than 7 days in 8 patients and less than 1 mo in 2 patients</td>
</tr>
<tr>
<td>2 AS</td>
<td>40, 47, 52</td>
<td></td>
<td></td>
<td></td>
<td>3/5</td>
<td></td>
</tr>
<tr>
<td>2 ASHD</td>
<td>(20–29)</td>
<td></td>
<td></td>
<td></td>
<td>(n = 2)</td>
<td></td>
</tr>
<tr>
<td>1 Marfan’s</td>
<td>AA 54, 60, 60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Unknown</td>
<td>DTA (n = 2)</td>
<td>38, 50</td>
<td>Not seen</td>
<td>DTA (n = 1)</td>
<td>2/5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(15–25)</td>
<td></td>
<td></td>
<td></td>
<td>(n = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AB (n = 2)</td>
<td>45, 90</td>
<td>Not seen</td>
<td>Not seen</td>
<td>3/5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(13–21)</td>
<td></td>
<td></td>
<td></td>
<td>(n = 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AA + Arch + DTA (n = 1)</td>
<td>AA 46, Arch</td>
<td>Not seen</td>
<td>Not seen</td>
<td>4–5/5 (1)</td>
<td></td>
</tr>
</tbody>
</table>

Angio = angiography; AS = aortic stenosis with poststenotic dilatation; CD = color Doppler; other abbreviations as in table 1.
<sup>a</sup>The numbers in parentheses represent the normal range of the aortic lumen inner diameter for that segment.<sup>21</sup>
<sup>b</sup>Confirmed by angiography in seven patients and at surgery in one.
real-time two-dimensional echocardiographic images. Wide-angle, phased-array transducers were used; transducer frequencies were 2.5 and 3.5 MHz. Echoes reflected from cardiac or vessel structures are displayed in a gray scale format to obtain a conventional two-dimensional study. Reflected pulses from blood are processed by the autocorrelation technique and the flow data displayed on the conventional two-dimensional echocardiographic image. The visual angle and the frame number are variable. The maximal frame rate utilizing the narrowest sector angle available (30 degrees) was 30/sec for the Aloka and 16/sec for the Toshiba equipment. Flow directed toward the transducer is conventionally coded in red, while flow directed away is coded in blue. Variations in velocity are represented by brightness and intensity of color. Since the color Doppler system is based on a pulse mode, the magnitude of flow velocity is limited in all points of the ultrasound sector. If turbulence occurs, green is added to the red or blue underlying color, thus changing the basic color tonality, with a resulting mosaic pattern. Color Doppler flow mapping studies were performed utilizing multiple echocardiographic planes and all the available sector angles. All images were permanently recorded on a ¼ inch (U-Matic) Sony or ½ inch VHS Panasonic videotape. Pictures were obtained either with a Polaroid camera placed in front of a small color TV monitor, or directly from the main screen by means of a 35 mm camera equipped with a lens capable of short focusing. Color flow mapping was also performed in an M mode format (superimposed on conventional M mode echocardiographic images) by selective placement of a line cursor on two-dimensional echocardiographic images.

Aortic regurgitation was diagnosed by color Doppler by noting the presence of diastolic disturbed flow in the left ventricular outflow originating from the aortic valve. Its severity was assessed by measuring the width of the regurgitant jet signals immediately below the aortic valve and expressing it as a percentage ratio of the left ventricular outflow tract width taken at the same level in parasternal long-axis or apical view. 22 Aortic regurgitation was graded mild (grade 1) if this ratio was less than 25%, moderate (grade 2) if it was between 25% and 50%, moderately severe (grade 3) if it was between 51% and 75%, and severe (grade 4 to 5) if it was greater than 75%. 22

Two observers independently reviewed two-dimensional and color Doppler studies of all patients with aortic dissection and those with dilated but nondissected aorta.

**Angiography.** Biplane cineangiograms were performed in all cases in the standard manner. Initially, they were performed in the left and right anterior oblique planes, and when necessary additional frontal and lateral projections were also obtained. Particular attention was given to the presence or absence of a dissection flap, opacification of the false channel, site of communication between the two lumina, and presence and severity of aortic regurgitation, which was graded on a scale of 1 to 5 by the criteria of Hunt et al. 21 The angiograms were interpreted by consensus by two observers who were blinded to the results of the color Doppler examination.

**Results**

There were no discrepancies in the two-dimensional echocardiographic and color Doppler findings of the two observers for both patient groups—aortic dissection and dilated aorta without dissection.

**Two-dimensional echocardiographic findings.** In all 16 patients with aortic dissection, two-dimensional echocardiography demonstrated prominent, flaplike, undulating motion of the inner dissected wall or marked parallel widening of an aortic wall (≥15 mm). These findings have been previously shown to be diagnostic of aortic dissection. 21 With multiple transducer positions previously described by us, 21 various aortic segments were visualized by two-dimensional echocardiography in each patient. This comprehensive approach enabled us to make a correct diagnosis of DeBakey type I dissection in 13 patients and type III dissection in three (see table 1).

The site of communication between the two lumina was suspected after two-dimensional echocardiography in four patients but could not be definitively differentiated from an artifactual echo dropout in any of them.

None of the 10 patients with nondissected but dilated aorta showed evidence of marked parallel widening of an aortic wall or presence of a linear moving echo within the aortic lumen (see table 2).

**Color Doppler findings**

**Aortic dissection.** The color Doppler findings in all patients with aortic dissection are summarized in tables 1 and 3.

**Flow patterns.** The color Doppler technique proved helpful in the delineation of blood flow characteristics in various segments of the dissected aorta. Flow was noted in both lumina of the dissected aorta in 12 of 13

### TABLE 3
Comparison of two-dimensional echocardiographic and color Doppler findings with angiographic results

<table>
<thead>
<tr>
<th></th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dissection flap</strong></td>
<td></td>
</tr>
<tr>
<td>Seen by CD and angio</td>
<td>16</td>
</tr>
<tr>
<td><strong>Presence of flow</strong></td>
<td></td>
</tr>
<tr>
<td>In both lumina by CD and angio</td>
<td>14</td>
</tr>
<tr>
<td>In one lumen only by CD and angio</td>
<td>2</td>
</tr>
<tr>
<td><strong>Site of communication between two lumina</strong></td>
<td></td>
</tr>
<tr>
<td>Seen by CD and angio</td>
<td>7 (2 AA, 2 Arch, 3 DTA)</td>
</tr>
<tr>
<td>Seen by CD, not by angio</td>
<td>2 (both AA)</td>
</tr>
<tr>
<td>Seen by angio, not by CD</td>
<td>3 (2 AA, 1 Arch)</td>
</tr>
<tr>
<td>Not seen by CD and angio</td>
<td>4</td>
</tr>
<tr>
<td><strong>AR severity</strong></td>
<td></td>
</tr>
<tr>
<td>Moderately severe (3/5) by CD and angio</td>
<td>4</td>
</tr>
<tr>
<td>Severe (4–5/5) by CD and angio</td>
<td>3</td>
</tr>
<tr>
<td>Moderately severe (3/5) by CD and angio inadequate to evaluate severity</td>
<td>1</td>
</tr>
</tbody>
</table>

Abbreviations as in tables 1 and 2.

*The interval between color Doppler studies and angiography ranged from within 24 hr to 8 days in all patients.

*CD did not detect an additional communication seen by angiography in the ascending aorta of one of these three patients.

*These sites of communication were confirmed at surgery in both patients.
patients with type I dissection and two of three with type III dissection. In two patients, one type I and one type III dissection, flow was noted in one lumen only. No evidence of blood flow could be elicited in the other lumen even when the instrument gain was substantially increased. Clot formation was noted in the nonperfused lumen in one of these two patients. Comparison of color Doppler findings with angiography is shown in table 3.

An interesting observation was the finding of bidirectional blood flow (flow in one direction in one lumen, flow in the opposite direction in the other lumen, both recorded simultaneously), which was noted mainly in early to midsystole in 12 of 13 patients with type I and two of three patients with type III dissection (figure 1). This abnormal flow pattern was not noted in all the visualized areas of the dissected aorta in any given patient but was confined to some segments only (table 1).

Identification of sites of communication. Color Doppler also proved useful in the delineation of sites of communication between the two lumina of the dissected aorta (figures 2 to 4). Of 12 patients in whom communication between the two lumina was demonstrated by angiography or surgery, color Doppler identified or predicted them in nine patients (four ascending aorta, two aortic arch, and three descending aorta). In three patients, a narrow jet of blood flow was clearly seen moving from one lumen into the other in the proximal ascending aorta and the sites of communication corresponded to those suspected on the two-dimensional echocardiogram (figure 2). In one of these three patients, blood flow was first identified in one lumen and then three to four frames later it was seen to move into the other lumen about 3 cm distal to the aortic valve. Immediately after, forward flow opacified both lumina with different color intensities, indicating different flow rates in the two lumina: greater brightness and hence higher velocity in the initially opacified lumen, less brightness and relatively lower velocity in the other one. This patient was restudied 1 month after surgery but blood flow could be detected in one lumen only, implying successful obliteration of the communication between the two channels. In the other two patients the sites of communication were more proximal (about 1 to 1.5 cm distal to the aortic valve) and no delay occurred in the opacification of the second lumen. In two patients with type I dissection, communication between the two lumina could be clearly delineated by observing flow signals moving from one lumen into the other through the dissection flap (aortic arch level in one and proximal descending aorta in the other). In one patient with type III dissection, frame-by-frame analysis of the thoracic descending aorta showed blood flow moving from the inner lumen through the dissection flap into the outer lumen during systole and then back into the inner lumen during diastole. This resulted in a biphasic “to and fro” flow pattern at the site of communication (figure 3).

In three patients the site of communication between the two lumina was not directly visualized by color Doppler but it could be predicted by the analysis of flow directions and timing in the aorta. One of these initially showed in the ascending aorta selective upwardly directed flow in one lumen with no flow in the other lumen. This incomplete aortic opacification per-
sisted for four to five frames; thereafter the previously nonopacified lumen demonstrated downward flow, while the first lumen still showed forward flow. The descending thoracic aorta, on the other hand, showed downwardly directed flow in both lumina, which were simultaneously opacified. These observations suggested that the communication was located in the aortic arch, distal to the ascending aorta but proximal to the descending aorta (figure 4). Subsequent angiographic studies confirmed the site of communication predicted by color Doppler. In the second patient, both lumina were simultaneously opacified by color Doppler and the site of communication was therefore thought to be in the proximal ascending aorta. This finding was subsequently confirmed at surgery. In the third patient (type I dissection), oppositely directed flows with a clearly demarcated junction were seen simultaneously in the same lumen in the proximal descending aorta. This finding suggested the presence of a communication between the two lumina at the junction of the oppositely directed flows so that blood entering this lumen was directed both upward and downward.24

Aortic regurgitation. In addition to determining blood flow characteristics in the dissected aorta, the color Doppler technique was also found useful in the assessment of associated aortic regurgitation. Aortic regurgitation was noted in eight patients, and by the criteria described in Materials and Methods, it was graded as severe (grade 4 to 5/5) in three patients and moderately severe (grade 3/5) in five (see tables 1 and 3). Seven of these patients had adequate angiographic studies and color Doppler findings correlated well with angiographic grading of severity in all of them.

Dilated aorta without dissection. None of the 10 patients with dilated aorta and no evidence of dissection showed aortic wall widening (≥15 mm) or presence of a linear moving echo within the aortic lumen (see table 2). Thus the question of detecting flow in two channels or finding a communication between them did not arise. Two of 10 patients in this group did show evi-
FIGURE 3. Color Doppler findings in aortic dissection. DeBakey type III dissection with site of communication between the two lumina in the descending thoracic aorta (DTA). A, Suprasternal long-axis view of the descending thoracic aorta. In systole (on the left) flow is noted in the inner lumen (IL) and is directed downward and away from the transducer (blue). In diastole (on the right) blood flow (upward direction, red) fills the outer lumen (OL), pushing the intimal flap against the aortic wall (inner lumen space is therefore reduced). Blood flow moves also from the inner lumen through the dissection flap into the outer lumen (arrow) during systole (left panel) and then back (arrow) into the inner lumen during diastole (right panel). B, Schematic.

dence of bidirectional flow in late systole and diastole but this was noted without the interposition of a dissection flap. This finding resulted from swirling of blood flow within the markedly dilated aortic lumen and backflow from aortic regurgitation. Also, unlike patients with dissection, bidirectional flow was not seen in early to mid-systole. Thus there was no difficulty in distinguishing patients with dissection from those with dilated aorta and no dissection.

Discussion

Improvement of surgical techniques has dramatically increased the survival rate of patients with aortic dissection. Therefore, early and accurate diagnosis is absolutely necessary for proper patient management. In this context, cardiac imaging techniques are useful not only for a prompt diagnosis but also for a correct anatomic classification of the type of dissection. These techniques have mainly been used to assess aortic size and to evaluate the site and extent of the dissection; little attention, on the other hand, has been paid to the evaluation of blood flow dynamics in both false and true lumina. This is probably explained by the technical limitations that most of the current imaging procedures present. Among these, cineangiography is certainly the most complete; in fact, it can indicate the site and extent of the dissection, the deformation of the true channel, the involvement of main branches, the concomitant presence and severity of aortic regurgitation and, in certain instances, the site of the proximal tear. Angiography, furthermore, also provides data on the presence or absence of flow in the false lumen. However, because of its invasive nature and the considerable risk of performing catheterization of a dissecting lumen, this technique can be used only in certain situations and certainly not for serial assessment.

Evaluation of blood flow dynamics in relation to the
anatomic features of the dissection is an attractive approach that presents interesting and promising applications not only for the understanding of the various functional and anatomic changes occurring in the different types of dissections but also for a better prognostic evaluation. The prognostic implications of the presence or absence of flow in the false lumen were demonstrated by Dinsmore et al.\textsuperscript{5}; in their series, the survival rate of patients with no flow in the false channel was higher (90\%) than in those with angiographic evidence of flow in both channels (43\%). The poor prognosis of patients with communication between the two lumina can be explained by the poor resistance to pulsatile flow of the thin outer lining of the false lumen. Conversely, in most patients without flow in the false lumen, the false channel becomes thrombosed and may provide a “natural buttress against future or further extension of the dissection.” A correct evaluation of patients with aortic dissection therefore requires an accurate knowledge not only of the anatomic changes but also of the alterations in blood flow.

**Color Doppler.** In the last few years color Doppler flow mapping has been the object of great interest.\textsuperscript{16-20} This new procedure, unlike other invasive and noninvasive techniques, provides the unique opportunity to study the distribution of intracavitary flow patterns while observing cardiac structure dynamics in real time.

In all the cases in our series, color Doppler correctly identified the presence or absence of flow in both lumina, which have well-known prognostic and therapeutic implications.\textsuperscript{5} In our study, four of 16 patients with dissection died (all during or within 24 hr of surgery) and in each of them flow had been noted in both lumina. On the other hand, neither of the two patients with flow visualized in only one lumen has

\textbf{FIGURE 4.} Color Doppler findings in aortic dissection. DeBakey type I dissection with site of communication between the two lumina in the aortic arch. A, Suprasternal long-axis view of the ascending aorta (A, AO). In early systole flow is noted in one of the two lumina (L1) and is directed toward the transducer (predominantly red with some backward flow due to swirling shown in blue). The other lumen (L2) remains unopacified. B, Schematic. C, In late systole, flow signals in the first lumen (L1) are still present and predominantly directed toward the transducer, while flow signals appear in the second lumen (L2) and are directed in the opposite direction (downward and away from the transducer, blue). These findings indicate that the site of communication between the two lumina is in the aortic arch. D, Schematic.
died. Although these findings appear to support the results of Dinsmore et al., it is possible that surgical intervention may have altered the prognosis in our patients. Also, the number of patients we studied is too small to derive any definitive conclusions regarding their prognosis.

In the case of nonsimultaneous opacification of both lumina in the proximal aorta, the lumen that opacifies first is likely to be the true lumen or the perfusing conduit. Simultaneous imaging of oppositely directed blood flows in the two lumina (bidirectional flow), seen in 14 patients, serves to enhance the confidence level with which an echocardiographic diagnosis of dissection is made since a relatively nonmoving dissection flap may be mistaken for equipment artifact. The color Doppler technique is also useful in identifying the sites of communication between the true and false channels by either direct visualization of flow signals moving from one lumen into the other or indirectly by analyzing differences in timing of opacification of the two lumina and flow direction. This finding has an important implication since one of the surgical aims is to interrupt flow in the false lumen. An important asset of the color Doppler technique in the evaluation of patients with aortic dissection is its ability to characterize the severity of associated aortic regurgitation. The conventional pulse or continuous-wave Doppler can provide information regarding presence or absence of flow in the two lumina but it cannot reliably characterize the sites of communication between them or the severity of associated aortic regurgitation. Thus, in our experience, color Doppler substantially supplements conventional two-dimensional echocardiography and pulsed Doppler techniques by providing a more comprehensive assessment of the flow dynamics in patients with aortic dissection.

Unlike angiography, this new imaging technique is totally noninvasive, easily repeatable, and therefore particularly useful in seriously ill patients in whom serial evaluations need to be carried out. However, even Doppler color flow imaging may be of limited value in some patients in whom the image quality is poor because of small acoustic windows.

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