

## Exercise and Physical Activity for the Post-Aortic

### Dissection Patient: The Clinician's Conundrum

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### **Abstract**

Despite the paucity of evidence, it is often presumed, and is physiologically plausible, that sudden, acute elevations in BP may transiently increase the risk of recurrent aortic dissection or rupture in patients with a prior aortic dissection, since a post-dissection aorta is almost invariably dilated and may thus experience greater associated wall stress as compared with a non-dilated aorta. Few data are available regarding the specific types and intensities of exercise that may be both safe and beneficial for this escalating patient population. The purpose of this editorial/commentary is to further explore this conundrum for clinicians caring for and counseling aortic dissection survivors. Moderate intensity cardiovascular activity may be cardioprotective in this patient cohort. It is likely that severe physical activity restrictions may reduce functional capacity and quality of life in post-aortic dissection patients and thus be harmful, underscoring the importance of further exploring the role of physical activity and/or structured exercise in this ‘at risk’ patient population.

Aortic dissection is due to disruption of the aortic wall integrity and architecture most often related to underlying genetic disorders (e.g., Marfan Syndrome), abnormal shear stress, inflammatory disease, trauma, or combinations thereof. It is a life-threatening medical emergency that, with immediate intervention, is now associated with improved rates of survival.<sup>1</sup> Currently, there is an ~90% survival rate to hospital discharge for patients with type B aortic dissection. The 1- and 3-year survival rates in patients with type A acute aortic dissection treated surgically approximate 96±2% and 91±4%, respectively.<sup>1</sup> Whereas progressive acute management (i.e., inclusive of use of medical therapies, open surgical, or endovascular approaches) has contributed to the improved survival, this patient subset maintains a heightened risk of aortopathy and associated cardiovascular events that may be favorably or unfavorably modulated by regular exposure to exercise.

Some case reports have described acute aortic syndromes that were identified after unusual or unaccustomed vigorous physical exertion, such as strenuous weightlifting or lifting heavy objects, suggesting that the trigger for the acute aortic syndrome was a transient excessive rise in blood pressure (BP).<sup>2-6</sup> Despite the paucity of evidence, it is often presumed, and is

physiologically plausible, that sudden, acute elevations in BP may transiently increase the risk of recurrent aortic dissection or rupture in patients with a prior aortic dissection, since a post-dissection aorta is almost invariably dilated and may thus experience greater associated wall stress as compared with a non-dilated aorta.<sup>7</sup> Consequently, it seems reasonable for post-aortic dissection patients to minimize physical activities that evoke a transient, disproportionate increase in BP to decrease the risk for future aortic dilatation, dissection, and/or rupture.<sup>7</sup>

On the other hand, because physical conditioning lowers the heart rate (HR) and systolic blood pressure (SBP) response at rest and at any given level of exercise, it is feasible that structured exercise programs might lower lifelong recurrent aortic risk during exertion and non-exertion related (e.g., emotional) stresses. Because beta-blockers are associated with improved survival in both type A and type B acute aortic dissection, most likely due to their HR and SBP lowering effects, it is plausible that regular exercise may also serve as a cardioprotective intervention for the aortic dissection patient, improving clinical outcomes by attenuating hemodynamic responses at rest and during any given level of exercise.<sup>8</sup> Furthermore, exercise, in contrast to medications, may also have the added benefits of improving quality of life, mental health, and functional capacity, making it a complementary intervention to the pharmacotherapeutic armamentarium of the aortic dissection patient.

Despite the potential benefits of exercise in the aortic dissection population, few data are available regarding the specific types and intensities of exercise that may be both safe and beneficial for this escalating patient population. The purpose of this editorial/commentary is to

further explore this conundrum for clinicians caring for and counseling aortic dissection survivors.

### **Clinician's Perspective**

Several years ago, we surveyed cardiovascular specialists (n=26) who participate in the International Registry of Aortic Dissection (IRAD) regarding physical activity recommendations for this patient cohort. For aerobic activities, 63% recommended moderate exercise, 26% recommended low impact exercise, and 10% had no restrictions. Many aortic disease specialists advised against weight lifting or resistance training (92%), competitive sports (46%), isometric exercise (46%), and participation in contact sports (54%). A majority (65%) reported that their recommendations were independent of the initial treatment intervention. Although most (58%) asked their patients to monitor SBP and HR during exercise, when asked to define safe upper limits for these hemodynamic responses during exercise, there was considerable variability in cut-points among the IRAD clinician-investigators. These survey results further highlight the current ambiguity regarding structured exercise/physical activity recommendations for post-aortic dissection patients.

### **Post-Aortic Dissection Patient Practices**

More recently, we sent a lifestyle survey to 82 aortic dissection survivors. Most respondents reported that they engaged in leisure-time walking before and after aortic dissection, 49 (60%) and 47 patients (57%), respectively. However, the number of survivors who engaged in no structured physical activity increased from 14 patients (17%) before aortic dissection to 20

patients (24%) after dissection, with many citing fear as the limiting factor. Furthermore, prior to aortic dissection, 31 patients (38%) engaged in sexual activity, whereas after aortic dissection, only 9 patients (11%) reported sexual activity, once again due to the perceived cardiac demands and the potential for recurrent cardiovascular events.

### **Physical Activity and Exercise**

Hatzaras et al.<sup>4</sup> reviewed 65 patients (24 women, 41 men) with an average aortic diameter of 5.6 cm prior to aortic dissection, detailing specific triggers for the events. Of these patients, 27% and 40% reported strenuous physical activity and severe emotional stress, respectively, immediately prior to dissection. In another series by Hatzaras et al.,<sup>3</sup> 31 patients (30 men, 1 woman, mean age 47.3 years) were identified (mean aortic diameter of 4.6 cm on initial imaging) who were engaged in weight training or heavy lifting at dissection onset. Despite these case series, the relationship between a triggering exercise exposure and acute aortic dissection is often not known, as selective patient recall (patients who do *not* suffer aortic dissection after vigorous exercise will not be reported) and publication bias (authors would have little incentive to report a series of “safe exercise encounters with no adverse outcomes” and editors would likely consider this a low priority) render calculations of the true relative or absolute risk tenuous at best.

Most, but not all patients with Marfan syndrome have aortic root dilatation. High intensity dynamic and isometric exertion, as well as contact sports are contraindicated for this vulnerable patient subset.<sup>8</sup> The Marfan Foundation physical activity recommendations are listed in table 1. However, these exercise and physical activity restrictions are largely based on opinion

and empiric experience, rather than scientific/clinical evidence. While the listed prescriptions and proscriptions seem reasonable, the limited knowledge base substantiating these recommendations served as the rationale for this editorial.

To our knowledge, only one study to date has evaluated the safety and efficacy of exercise-based cardiac rehabilitation in post-aortic dissection patients. Corone et al.<sup>9</sup> reported on 33 French patients (25 men, 8 women) with type 1 DeBakey aortic dissection (mean age, 55.1 years) who underwent cardiac rehabilitation soon after surgical repair (mean, 27 days). Average resting SBP at hospital discharge was 120 mmHg; most of the patients (97%) were taking beta-blockers. Patients with poorly controlled SBP at rest were excluded. The intervention group was followed up at 6 and 12 months. During cardiac rehabilitation, exercise training was performed on a cycle ergometer, using a moderate intensity (11.3 or “fairly light” on the Borg 6 to 20 scale). Systolic BP during exercise remained < 150 mmHg in 25% of the patients, was between 150 and 160 mmHg in half of the patients, and averaged 160-170 mmHg in the remaining patients. The mean baseline maximum physical work capacity increased from 62.7 W/min to 91.6 W/min at the conclusion of the intervention (p-value= 0.002). Follow-up was for one year and in total there were 3 complications, including 2 patients that required additional thoracic aortic surgery. These data suggest that moderate intensity, non-contact aerobic activity is likely safe and effective for selected post-aortic dissection patients. Accordingly, moderate intensity exercise training is currently used in post-aortic dissection patients referred to cardiac rehabilitation centers in France.

## Recommendations

Few data are available regarding exercise tolerance and physical activity recommendations for patients who have survived an aortic dissection. Most of the limited number of available reports pertain to patients with a history of thoracic aortic aneurysm prior to dissection. Unaccustomed vigorous physical activity, acute emotional stress, and heavy lifting have been suggested as triggers for aortic dissection in patients with pre-existing aortic aneurysm.<sup>3,4</sup> According to the Law of LaPlace, the aortic wall experiences greater stress at a given SBP as aortic size increases. In contrast, even near-maximal to maximal levels of physical exertion do not appear to result in dangerous elevations of wall stress in normal, non-dilated aortas.<sup>10</sup> Thus, for patients with known aortic dilatation or underlying aortopathy, high-intensity aerobic and isometric activity is most likely contraindicated.

Regular aerobic exercise lowers resting SBP over time, on average, by a modest amount (3-8 mmHg), with moderate intensity exertion being more effective than high intensity training.<sup>11</sup> Moreover, a lower resting SBP is associated with a reduced risk of future aortic complications.<sup>12-16</sup> Dynamic aerobic activity is typically categorized by intensity level, using the relative HR response, estimated metabolic equivalents (METs; 1 MET = 3.5 mL O<sub>2</sub>/kg/min), and the percent of maximal voluntary contraction (MVC) for young, middle-aged and older adults (Table 2).<sup>17</sup> The general public health recommendation is to engage in moderate intensity aerobic activity (3-5 METs) for at least 30 minutes on most days of the week, for a minimum of 150 minutes per week.<sup>17</sup> This suggests that high intensity exercise is not necessary to provide the hemodynamic



benefits of exercise. Thus, for many post-aortic dissection patients, age-adjusted light-to-moderate dynamic exercise, such as comfortable-to-brisk walking and/or cycling at a perceived exertion of “fairly light” to “somewhat hard” should be reasonably safe and well-tolerated. A light to moderate weight training program limiting the amount of weight utilized per set, and stopping well short of volitional fatigue and Valsalva, has been suggested as potentially beneficial in selected patients and should be encouraged.<sup>17</sup> Sexual activity, which approximates an aerobic requirement of 2-3 METs, is most likely safe and should not be discouraged in this patient cohort.<sup>18</sup>

### **Role of Antihypertensive Agents**

Beta-blockers, calcium channel blockers, angiotensin converting enzyme inhibitors (ACE), and angiotensin receptor blockers (ARBs) are commonly prescribed to lower SBP in patients with aortic dissection. Beta blockers, by reducing HR, myocardial contractility and abrupt increases in ventricular pressure (dP/dt), are particularly therapeutic post-dissection.<sup>1</sup> Patients taking antihypertensive medications may safely tolerate greater intensities of exertion as a lower resting SBP leads to attenuated average and peak SBPs during physical activity as compared with uncontrolled hypertensive individuals. Beta-blockers also limit the magnitude of SBP increase during activity, suggesting greater efficacy in attenuating the exertion-related SBP rise as compared with other antihypertensives.<sup>19-28</sup> This suggests that the same activity restrictions do not apply to patients taking BP medications compared with those not taking BP medications, and that post-aortic dissection patients with uncontrolled hypertension should

markedly limit their physical exertion. However, varied SBP responses to progressive levels of physical activity may occur in any given patient, depending on superimposed environmental, circadian, and emotional stressors.

## **Conclusion**

Although there are few data regarding safe exercise practices in aortic dissection survivors, numerous studies now suggest that usual gait speed, distance covered during walk performance tests, and weekly walking distance/time are powerful predictors of mortality and future cardiovascular events in patients with and without heart disease, including those with heart failure.<sup>29,30</sup> Potential triggers of aortic dissection and cardioprotective interventions are shown in Figure 1. It appears that varied exercise doses can both protect against and provoke acute cardiac events, including aortic dissection, especially when the exertion is unaccustomed.

The post-aortic dissection patient's functional capacity and habitual physical activity should be regularly assessed. Exercise testing may be performed to identify adverse exertional signs/symptoms (i.e., chest pain, dyspnea, threatening ventricular arrhythmias, hypohypertension), and perceived exertion and chronotropic responses at progressive MET levels. These data should be used to develop a safe and effective exercise prescription and to adjust antihypertensive medication dosages to permit a higher exercise intensity to be achieved with reduced cardiac demands (e.g., rate-pressure-product). Moreover, the exercise prescription should be re-evaluated on a serial basis. A trained physiologist, exercise therapist or nurse clinician should be available for counseling and supervision, at least during the initial training

sessions, and ideally thereafter. In summary, it is likely that severe physical activity restrictions may reduce functional capacity and quality of life in post-aortic dissection patients and thus be harmful, underscoring the importance of further exploring the role of physical activity and/or structured exercise in this ‘at risk’ patient population.

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**Table 1.** The Marfan Foundation physical activity recommendations

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- Noncompetitive, isokinetic activity performed at a nonstrenuous aerobic pace, minimizing sudden stops, rapid changes in direction, or contact with other players, equipment or the ground
  - Performing aerobic activity at a moderate intensity (~50% of aerobic capacity) and maintaining heart rate < 100 beats per minute (bpm) or < 110 bpm for patients on and off beta-blockers, respectively;
  - Avoiding exercise involving a substantial isometric component such as weightlifting, climbing steep inclines, gymnastics, and pull-ups;
  - Avoiding activities that are associated with rapid changes in atmospheric pressure (scuba diving, flying in unpressurized aircraft).
  - For resistance training, higher repetitions at lower weights are recommended as opposed to lower repetitions with heavier weight, stopping before muscle fatigue.
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**Table 2.** Exercise Intensity, METs, and MVC Based on Age\*

Intensity	Maximal heart rate (%)	METs in healthy adults (age 28-39 yr)	METs in healthy adults (age 40-64 yr)	METs in healthy adults (age 65-79 yr)	Maximal voluntary contraction (%)
Very light	<35	<2.4	<2.0	<1.6	<30
Light	35-54	2.4-4.7	2.0-3.9	1.6-3.1	30-49
Moderate	55-69	4.8-7.1	4.0-5.9	3.2-4.7	50-69
Hard	70-89	7.2-10.1	6.0-8.4	4.8-6.7	70-84
Very hard	≥90	≥10.2	≥8.5	≥6.8	≥85
Maximal	100	12.0	10.0	8.0	100

\*Adapted from reference #17.

**Figure 1.** Potential triggers and cardioprotective interventions for acute aortic dissection

### Aortic Dissection: Potential Triggers and Cardioprotective Interventions



#### Triggers

- Marfan Syndrome
- Abnormal shear stress
- Inflammatory disease
- Trauma
- Unaccustomed exertion
- Lifting heavy objects
- Emotional stress
- Scuba diving
- Isometric activities
- Anaerobic contact sports

#### Cardioprotective Interventions

- Beta-blockers
- Calcium channel blockers
- ACE inhibitors
- ARBs
- Physical conditioning
- Moderate intensity training