Resistance Training for Patients With Hypertension

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According to the American College of Sports Medicine (3), endurance training may reduce systolic and diastolic blood pressure an average of 10 mmHg in individuals with mild hypertension (pressures of 140–180 over 90–105 mmHg). The ACSM recommends aerobic activities 3 to 5 days a week for 20 to 60 min a day at 40% to 70% of one’s maximal oxygen uptake. They also state that resistance training is safe to include as part of a well-rounded fitness program for hypertensive patients.

This article reviews the effects of resistance training and suggests effective and safe resistance training programs for patients with hypertension.

For our purposes here, circuit weight training is defined as lifting a weight equal to 40 to 60% of 1-RM for 10 to 20 reps in a 30- to 60-sec period. After a rest of 15 to 45 sec, the lifter moves to the next exercise. Usually 8 to 12 exercises are included in the circuit, and the circuit may be repeated 2 or 3 times a session.

In contrast, traditional weight training involves lifting weights equal to 60 to 90% of 1-RM for 4 to 12 reps. This is repeated for 2 to 4 sets with a 1- to 2-min rest between sets.

Table 1
Classification of Blood Pressure (mmHg)

<table>
<thead>
<tr>
<th>Category</th>
<th>Systolic</th>
<th>Diastolic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt; 130</td>
<td>&lt; 85</td>
</tr>
<tr>
<td>High normal</td>
<td>130–139</td>
<td>85–89</td>
</tr>
<tr>
<td>Hypertension</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage I (mild)</td>
<td>140–159</td>
<td>90–99</td>
</tr>
<tr>
<td>Stage II (moderate)</td>
<td>160–179</td>
<td>100–109</td>
</tr>
<tr>
<td>Stage III (severe)</td>
<td>180–209</td>
<td>110–119</td>
</tr>
<tr>
<td>Stage IV (very severe)</td>
<td>&gt; 209</td>
<td>&gt; 119</td>
</tr>
</tbody>
</table>

The discussion in this article is limited to the management of upper normal and Stages I or II high blood pressure and should not be applied to Stages III or IV. Stage II patients should be under a doctor’s care. Table 2 lists common classes of anti-hypertensive medications and their effects on exercise capacity. The prevalence of hypertension increases with age and is more common in blacks.

In about 90% of cases the cause of hypertension is unknown.
<table>
<thead>
<tr>
<th>Class</th>
<th>Action</th>
<th>Exercise Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ace inhibitors (minipril,</td>
<td>Blocks angiotensin converting enzyme (a</td>
<td>No effect on exercise capacity</td>
</tr>
<tr>
<td>zestril, lotensin, capoten,</td>
<td>potent vasoconstrictor)</td>
<td></td>
</tr>
<tr>
<td>prinivil, acupril)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beta blockers (inderal,</td>
<td>Blocks beta 1 and/or 2 receptors, slowing</td>
<td>Decreases exercise capacity by</td>
</tr>
<tr>
<td>toprol, lopressor, tenormin,</td>
<td>heart rate and decreasing myocardial</td>
<td>10%</td>
</tr>
<tr>
<td>corgard, blocadren, visken,</td>
<td>contractility</td>
<td></td>
</tr>
<tr>
<td>sectral)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium blockers (cardizem,</td>
<td>Blocks calcium entry into smooth muscle,</td>
<td>No effect on exercise capacity</td>
</tr>
<tr>
<td>procardia, calan, norvase,</td>
<td>causing vasodilation of peripheral coronary</td>
<td>or have no effect</td>
</tr>
<tr>
<td>dillaco, cardene)</td>
<td>arteries</td>
<td></td>
</tr>
<tr>
<td>Diurettes (diuril, lozol,</td>
<td>Reduces fluid volume, thus reducing cardiac</td>
<td>May decrease exercise capacity</td>
</tr>
<tr>
<td>lasix, bumex, hygroton)</td>
<td>cardiac output and blood pressure</td>
<td>or have no effect</td>
</tr>
<tr>
<td>Alpha blockers (minipress,</td>
<td>Blocks alpha receptors in peripheral</td>
<td>No effect on exercise capacity</td>
</tr>
<tr>
<td>hytrin, cardura, catapres)</td>
<td>arteries, causing vasodilation</td>
<td></td>
</tr>
</tbody>
</table>

Some known causes include kidney disease, renal artery obstruction, adrenal gland tumor, and obstruction of the aorta such as congenital coarctation. Known causes of hypertension must be treated and corrected before beginning an exercise program.

Patients with hypertension are at a higher risk for stroke and heart disease. The risk increases in a gradual manner at blood pressures above 120/80 mmHg. Untreated hypertension also leads to end organ damage. Studies show that even sustained mild elevations of blood pressure can damage the kidneys and arteries (16).

**Acute Effects of Resistance Training**

Traditionally, resistance training was prohibited in hypertensive patients due to fears of precipitating a heart attack or overloading an already compromised myocardium. These fears were reinforced by McDougall et al. (18), who reported intra-arterial pressures as high as 400/200 mmHg in weightlifters during exhaustive supramaximal efforts. However, studies in patients with coronary heart disease (CHD) found only modest elevations of SBP and DBP during circuit weight training at 40 to 60% of 1-RM (8, 9, 20).

A recent study (19) on 8 normotensive healthy young adults reported a heart rate response of 70% of predicted HR max during circuit weight training at 47% 1-RM compared to 62% of predicted HR max during traditional weight training at 69% 1-RM. Double product (HR × SBP) and energy expenditure in total Kcal and Kcal per minute also were significantly greater during circuit weight training.

Stewart et al. (22) found modest hemodynamic responses to circuit weight training in patients on two anti-hypertensive medications. For example, SBP and DBP responses did not differ significantly between patients on placebo, diltiazem (cardizem), or propranolol (inderal). Responses were similar to aerobic exercise at 70% maximal oxygen uptake. In most studies, double product was lower during circuit weight training than during aerobic exercise up to 80% 1-RM.

In addition, there is no definitive evidence of increased disturbances of heart rhythm or function during circuit weight training. Haslam et al. (9) reported no significant symptoms or ECG changes in 8 patients with CHD during resistance exercise at 80% 1-RM. Butler et al. (5) found no abnormalities of left ventricular wall motion during circuit weight training in CHD patients with preserved ventricular function.

In summary, circuit weight training at 40 to 70–80% 1-RM in hypertensive patients is safe from a hemodynamic, electrocardiographic, and mechanical perspective. Below is a summary of acute responses to moderate circuit weight training compared to aerobic exercise in borderline hypertensive patients:

- Heart rate: lower than during aerobic exercise:
• SBP: similar to aerobic exercise;
• DBP: higher than aerobic exercise;
• Rate pressure product (HR × SBP): similar to aerobic exercise;
• Left ventricular function: similar to aerobic exercise.

III Chronic Effects of Resistance Training

In light of the known effects of untreated hypertension on left ventricular mass and function, a concern about increases in DBP and afterload during circuit weight training is warranted. Increases in left ventricular mass result from normal physiologic or pathologic stress (chronic hypertension, valvular disease, heart failure, or structural disorders such as idiopathic hypertrophic cardiomyopathy).

Physiologic stress is classified as either volume or pressure overload. Resistance training induces a pressure overload that results in a concentric thickening of the myocardium (13). Endurance training induces a volume overload that results in an eccentric hypertrophy of the myocardium.

It is clear that the stress-induced hypertrophy of either resistance or endurance training is less critical than that induced by pathology (18). The mass of a pathologically hypertrophied left ventricle is 250 to 300 grams whereas the average left ventricular mass in endurance or resistance trained athletes is 190 to 205 grams (14, 18).

In individuals without hypertension, physiologic hypertrophy seldom exceeds 3.5 g per kilogram of body weight (23). In addition, increases in left ventricular mass associated with resistance training do not differ from those of controls when corrected for lean body mass.

Pathologic hypertrophy of the left ventricle is known to cause systolic and/or diastolic dysfunction (21). In contrast, physiologically hypertrophied hearts demonstrate enhanced cardiac performance during both systole and diastole (11, 13).

Keleman et al. (12) conducted a 10-week study on patients with borderline hypertension to examine the effects of circuit weight training combined with aerobic exercise training using 40 to 60% 1-RM. The patients were assigned randomly to medical therapy with either inderal, cardizem, or placebo. Results of pre and post echocardiographic studies were as follows:

1. SBP and DBP decreased by 12/10 mmHg in all groups.
2. Left ventricular mass increased by 8 to 12% in all groups.
3. Peak left ventricular filling velocity improved in all groups.
4. Neither drug interfered with these training responses.

Keleman et al. concluded that combined aerobic and circuit weight training at 40 to 60% 1-RM results in a physiologic hypertrophy in

Guidelines for a Circuit Weight Training Program

1. Select 8 to 12 exercises to get a well-balanced program.
2. Establish a conservative 1-RM in each exercise or a 10-RM on 3 to 4 key exercises.
3. Use 40 to 60% of 1-RM.
4. Do 10 to 20 reps in 30 to 60 sec.
5. Do 2 or 3 sets of each exercise in a circuit pattern, alternating between upper and lower body and moving from large- to small-muscle-group exercises.
6. Begin with a 45-sec rest between sets and gradually reduce to 15 to 30 sec.
7. Train 2 or 3 days a week.
8. Machine weights are preferable for hypertensive patients.
9. Be sure you understand equipment purpose and technique of each exercise.
10. Emphasize full range of motion and proper posture during all exercises.
12. Perceived exertion during the circuit should be 12-14.
13. Avoid straining or heavy lifting; emphasize aerobic circuit training.
14. Be sure you understand proper breathing to avoid the Valsalva maneuver.
15. Maintain a firm handgrip, but not too tight, to avoid a pressor response that may cause excessive rises in BP.
16. Establish goals and maintain careful records of workloads, heart rate, and BP responses in order to monitor progress.
17. Repeat 1- or 10-RMs every month or so for the first 4 to 6 months, then less often thereafter.
18. When you can comfortably complete 2 to 3 circuits with a given load, increase the load by 2-1/2 to 10 lbs.
19. Be sure to adhere to medical regimen as prescribed by your physician.
hypertensive patients similar to that seen in normotensive individuals. The researchers also found no among-group differences in SBP or DBP, suggesting that antihypertensive medications did not provide any added benefit.

**Effects on Elderly Persons**

The elderly constitute a rapidly increasing segment of our population. In fact the oldest old, defined as those over 85, are the fastest growing subgroup. There has been little study on the effects of circuit weight training in general, and on hypertension in particular, in the elderly. Two studies by Fiatarone and colleagues (6, 7) demonstrate remarkable improvements in strength and function in frail elderly persons who undertook resistance training.

In the first study, resistance training of the quadriceps consisted of 3 sets of 10 reps at 80% 1-RM for 8 weeks and led to a 174% increase in strength; the subjects were 86 to 96 years of age. The second study involved 100 subjects, ages 72 to 98, who were randomized to 4 groups: control, resistance exercise, nutritional supplement, or exercise + supplement. Results revealed an 85 to 113% increase in strength in the 2 groups that exercised.

A significant finding of these studies was that there were no adverse cardiovascular effects from high intensity resistance training in these very old persons, 35% of whom had hypertension.

Finally, a recent study (17) involving women 60 to 77 years of age reported a significant reduction in heart rate, SBP, and double product during standard submaximal walking and weight loaded walking tests after 16 weeks of traditional strength training at 50 to 67% 1-RM. Similar findings have been reported following circuit weight training which is associated with a 13 to 40% increase in strength after 13 to 156 weeks (1).

The benefits of circuit weight training in patients with borderline hypertension can be summarized as follows:

- Increased muscle strength
- Increased endurance
- Increased lean body mass
- Increased metabolism
- Lower SBP and DBP
- No adverse effect on ventricular function
- Possibly improved lipids
- Reduced cardiovascular stress during daily tasks
- Increased self-efficacy
- Slight increase in max oxygen uptake
- Enhanced physique
- Less anxiety/tension
- Improved glucose tolerance

It seems logical to conclude that for Stages I and II hypertensive patients, the benefits of circuit weight training at 40 to 70–80% 1-RM outweigh the potential risks. Proper instruction and supervision should enhance the safety, efficacy, and enjoyment of circuit weight training for hypertensive patients.

**Resistance Training Guidelines**

Hypertension is a major risk factor for cardiovascular disease. Therefore, persons with hypertension should undergo appropriate medical screening before attempting a vigorous exercise program. The American College of Sports Medicine (2) recommends that men over 40 and women over 50 undergo maximal exercise testing with physician supervision prior to starting a vigorous aerobic exercise program.

It would seem prudent to recommend a similar screening process for patients with hypertension prior to beginning a resistance training program.

In regard to exercise testing protocol, it is important to monitor blood pressure carefully in each workload and during recovery. Individuals with high normal or Stage I or II high BP who do not take anti-hypertensive medication may have an exaggerated BP response to exercise. It may be helpful to monitor blood pressure during a 1-min handgrip test using 50% of maximum force to screen for an exaggerated BP response.

Blood pressure should also be monitored frequently before, during, and after resistance exercise during the first few weeks of participation. There are several reasons for this:

1. To establish a baseline pre-training BP;
2. To monitor for contraindications (BP greater than 179/109 before exercise);
3. To document responses during training;
4. To monitor the effects of resistance training at post-exercise (with aerobic exercise, BP often falls below preexercise levels and may remain lower for several hours);
5. To reinforce the training habit by demonstrating improvements.

General guidelines for a circuit weight training program for patients with hypertension are listed in the sidebar. These guidelines are not all-inclusive. A well prescribed circuit weight training program can provide hypertensive patients with many benefits in a safe manner. The improvements in muscle strength and endurance
they get from a sound program of resistance training will help them better perform both occupational and leisure tasks and enhance their quality of life.

References


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