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Resistance Training in Paraplegia: Rationale and Recommendations

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PARAPLEGIA IS DEFINED BY Schmitz (8) as "a partial or complete paralysis of all or part of the trunk and both lower extremities resulting from lesions of the thoracic or lumbar spinal cord or sacral roots." The higher the lesion level, the more extensive are the deficits. Spinal cord injury (SCI) may be complete or incomplete, with the latter being more common and less severe. Although some persons with paraplegia can walk with specialized equipment, most persons with paraplegia use a wheelchair as their primary mode of mobility. SCI may be from either traumatic or nontraumatic causes. Traumatic SCI is nonprogressive, but certain types of nontraumatic SCI may result in progressive neuromuscular and sensory dysfunction.

Nontraumatic causes of SCI are less common (~30% of total SCI) than traumatic causes (8) and include spinal stenosis (bony narrowing of the vertebral canal), tumor, ischemia (lack of blood flow), and infection (5). A congenital disorder that may result in paraplegia is spina bifida, in which closure of the vertebral canal is incomplete, leaving the spinal cord partially unprotected and vulnerable to injury (5).

In the United States, causes of traumatic SCI include motor vehicle crashes (37.4%), violence (25.9%), falls (21.5%), and sports (7.1%). It is estimated that the U.S. annual incidence of SCI is 10,000 per year. Prevalence is estimated to be between 183,000 and 230,000 persons. Adults 16 to 30 years old make up 55% of persons with SCI. There is a profound gender difference, with males representing 80.6% of individuals with traumatic SCI (9).

Treatment for nontraumatic SCI relies greatly on surgical intervention but varies with the particular pathology. Current strategies to improve the prognosis of traumatic SCI include injection of methylprednisolone to reduce inflammation immediately after acute SCI. In animals, early investigations of cell grafts across the spinal cord lesion site have shown promise (6). However, for those with subacute SCI, primary treatment centers on rehabilitation, which may be complemented by experimental techniques such as functional electrical stimulation or assisted treadmill walking while suspended from a harness (2).

Hypothetical Benefits of Resistance Training in Paraplegia

According to a recent statement of the American Heart Association, primary (local) and secondary (systemic) benefits of regular resistance training (RT) include improvements in strength, body composition, bone mineral density, blood lipid ratios, blood pressure, blood glucose metabolism, and sense of well-being (7). Thus, several risk factors for coronary artery disease, namely a sedentary lifestyle, hypertension, hypercholesterolemia, obesity, and impaired fasting glucose, may be modified through participation in an RT program.

A thorough search of the CINAHL (nursing and allied health literature), MEDLINE (medical lit-

erature), and SPORT Discus (sport and fitness literature) databases revealed no prospective or cross-sectional studies that examined conventional RT as an intervention in paraplegia. Although RT research in paraplegia is lacking, in a previous publication, we proposed RT as an effective intervention for several of the medical complications associated with paraplegia, regardless of the etiology (3). Because several of the complications of paraplegia may be attributed to a sedentary lifestyle, we further postulated that persons with paraplegia may enjoy similar benefits of regular exercise as those enjoyed by nondisabled persons (3). Other hypothetical benefits of resistance training that specifically address issues related to paraplegia include (a) enhanced ability to perform activities of daily living, (b) maneuverability within the environment, and (c) correction of muscle imbalances that occur with chronic wheelchair propulsion (3). Additionally, wheelchair-dependent athletes may obtain the same protective and performance-enhancing effects of RT as do their ambulatory counterparts (3).

A possible limitation of extrapolating the previous RT research to persons with paraplegia is that the beneficial systemic effects of RT (i.e., improved glucose tolerance) have been demonstrated with whole-body routines (i.e., routines that include the upper and lower body). Because the lower body constitutes such a large portion of the body's muscle mass, it is uncertain to what extent persons with paraplegia will benefit from RT. The inability to train the legs reduces the potential caloric expenditure as well as the potential net accretion of muscle mass that would be expected to increase the basal metabolic rate. We speculate that persons with paraplegia can derive favorable, clinically significant systemic responses to habitual RT, but the effects may be less than for ambulatory persons.

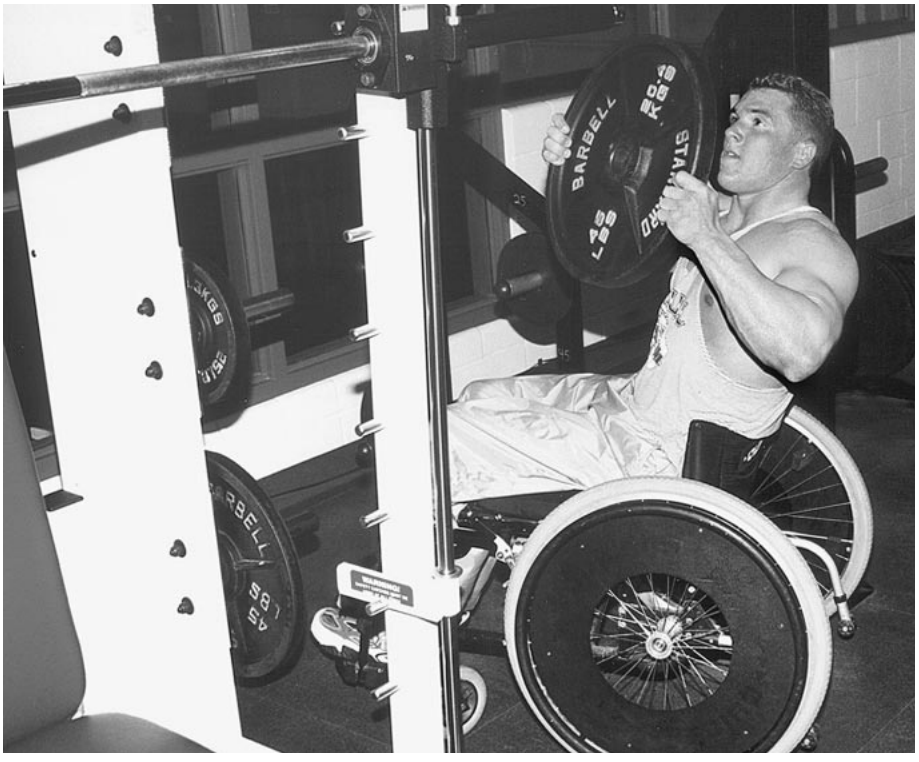

Figure 1. **Amateur bodybuilder Steve Zaracki implemented resistance training as a component of his post-rehabilitative care after a traumatic SCI (photo by Craig Crookston).**

Environmental Considerations

Physical barriers for individuals with paraplegia may persist in older or smaller fitness facilities. Limited parking, stairs, narrow doorways, compact restrooms, and closely spaced gym equipment pose obstacles to those in wheelchairs. Even wheelchair-accessible workout facilities may require an innovative approach to adapting resistance exercises to accommodate the special needs of the trainee with paraplegia (3). However, many resistance exercises can be readily adapted at minimal expense and inconvenience in a modestly equipped fitness facility (3). Figures 1 and 2 demonstrate a person with paraplegia using standard gym equipment for RT.

Medical Considerations

There are a few important medical considerations that the strength and conditioning professional should be aware of when working with this population. First, one must be alert to the possibility of autonomic dysreflexia, which can occur in persons with lesions at T6 or above and which causes extreme hypertension, which can lead to stroke. Possible symptoms of autonomic dysreflexia include increased blood pressure, headache, excessive perspiration, and facial flush (4). Second, venous pooling in the lower extremities may lead to hypotension, which can be minimized with the use of support

Figure 2. **Many exercises, such as cable abdominal crunches, lend themselves to being adapted for use by an individual with paraplegia (photo by Craig Crookston).**

hose and an abdominal binder if necessary. Additionally, one should be cognizant of medications that a person with paraplegia is taking, especially drugs that can induce hypotension or diuresis (4). Finally, the strength and conditioning professional must maintain close communication with the patient's medical team, working only under referral and within medically prescribed guidelines.

Exercise Prescription

In terms of program design, an RT program for a person with paraplegia should incorporate exercises that will help restore muscle balance around functional joints. For example, it is not uncommon for people who use wheelchairs to overdevelop the anterior shoulder musculature. Accordingly, an RT regimen should emphasize developing the posterior shoulder musculature to help provide balance and stability to the shoulder joint (3).

For persons with SCI, Figoni (4) recommends the conventional 3 sets of 8–12 repetitions, performed twice weekly with the available active musculature. Until population-specific RT research is conducted, we suggest following the ACSM's guidelines (1) for healthy individuals, which state that a single set to fatigue of 8–12 repetitions for 8–10 exercises, performed 2–3 times per week, can provide considerable health benefits. As with all RT programs, it is advisable to emphasize proper breathing and exercise technique during RT. Given the high frequency of overuse injuries of the shoulder in this population (4), we propose that 8–10 exercises might be excessive from a musculoskeletal perspective, as these are intended to be divided between upper and lower body. However, this increase in upper-extremity training may actually elicit more pronounced systemic-training benefits than would a program with reduced volume. Careful monitoring for pain related to overuse injuries is critical to a safe and effective program (4). Finally, until additional research determines the optimal volume of RT in paraplegia to achieve local and systemic training effects, these general guidelines will allow the strength and conditioning professional to develop an RT program that will improve the patient's self-image, health, and quality of life. ▲

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