

STRENGTH TRAINING AND CP

Richard Koscielny

“All human movement, from the blinking of an eye to the running of a marathon, depends on the proper functioning of skeletal muscle and its strength.”(5)

Why do we need strength?

Does a person with CP need strength training?

These are some of the questions that we ask ourselves as parents and therapists. The answer to the first question is simple. Without strength we are unable to live. Each movement of our body depends on muscle strength. Without strength we are unable to eat, talk, walk, move and breathe. Strength of the muscle is essential to perform daily activities and learn new functions. We can survive without endurance, speed, and flexibility, but we cannot without strength. Very often we forget about its importance.

Is strength training important for CP?

Muscle strength is even more crucial for individuals with a disability than for those without. It has been confirmed by studies and clinical experience.

Many times to help our children we try new methods of therapy involving sophisticated technology, medication and surgeries. We are able to use surgical procedures to decrease mm tone and improve alignment of the bones. It is great, but very often not enough to learn a new function (walk, roll, sit). To learn those skills, we need to develop strength to control the muscles and the body.

“Previously children with CP were not encouraged to strength train because it was felt this would increase spasticity and reduce flexibility, which would lead to the worsening of deformities and walking problems.”(1)

In this article I will present existing misconceptions about strength training. I will describe very important facts about the development of strength in young individuals, and explain the success of intensive therapy programs.

1. Misconceptions of strengthening programs

Many specialists still believe that strength training is not appropriate in individuals with cerebral palsy because:

- weakness is not a significant functional problem for them
- an increase in strength will not improve function
- most of them cannot control their muscles sufficiently to train them
- increased strength will increase spasticity
- strengthening programs result only in hypertrophy of the muscles, and it does not effect the nervous system

Another misconception involves the confusion about the difference between weight (strength) training and weight lifting.

2. Facts

Dispelling these beliefs, many recent studies have demonstrated that:

1. even mildly affected persons with CP have significantly reduced muscle strength, with the degree of weakness even greater in those with greater neurological involvement. In fact, weakness appears to have a stronger relationship with the level of motor functioning than other common symptoms such as spasticity or muscle tightness.
2. individuals with CP can increase strength and improve passive motion through weight training.
3. individuals with CP can increase strength in most if not all muscles at the same rate as persons without a brain lesion. Most importantly, strength training programs can produce positive changes in walking ability and in the performance of other motor tasks. There is

evidence of a relationship between lower limb strength values and motor abilities. An increase in strength of one muscle group does not change the outcome of function, but improvement in strength of more muscle groups will result in significant improvement of functional skills.

4. no evidence exists to support the claim that strengthening exercises will increase spasticity. Strength training is perhaps most effective when performed in conjunction with other types of activities, exercises, or therapeutic interventions. In 1956, Massey and Chaudet demonstrated that heavy resistance training does not cause a decrease in flexibility. Spasticity has not been found to increase with strength training in the research done by Damiano, Mac Phail and Holland.

5. weight (strength) training for children is based basically on resistive exercises using their own body weight instead of lifting heavy weights. Our children are constantly doing resistive (strengthening) exercises using the weight provided from the child's own body. When a youngster does a push up, he lifts 60% of his body weight. If the child weights 50 pounds, he will lift 30 pounds performing push ups. Weightlifting, on the other hand, is a competition where participants lift as much weight as they can at one time.

Facts about CP and strength

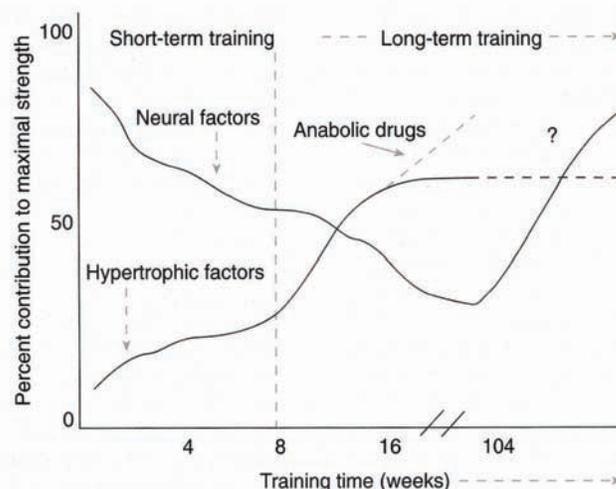
- Generally individuals with CP are weak
- Spasticity is not related to mm strength
- Strength in CP is directly related to function
- Strengthening does not increase spasticity
- The energy cost of walking in children with CP can be up to three times greater than children without CP
- Children with CP complain of fatigue at a very low exercise intensity
- Excessive coactivation within and between body segments could be responsible for the high energy cost of walking in children with CP

3. Strength development

For many years, strength gains were assumed to result directly from increases in muscle size (hypertrophy). Current research (Meredith, Frontera) proved that prepubescent strength gains are accomplished largely without any changes in muscle size. Young individuals develop strength through:

- improved motor skills coordination
- increased motor unit activation
- and other neurological adaptations

“During the first several weeks of resistive training, gains in strength are almost exclusively **neural in nature**, meaning the body is learning to recruit the correct muscles in the proper sequence while inhibiting unnecessary muscle recruitments. The physiologic changes, such as an increase in contractile proteins, stored nutrients, and anaerobic enzymes, take several weeks to develop. Once the neurologist “learning” phase begins to diminish, remodeling of the muscle is beginning to take place and strength gains continue.” (LeMura)



Dynamic interplay of neural and hypertrophic factors for increased strength (5)

During the first 2-4 weeks strength gains can be achieved without structural changes in the muscle, but not without neural adaptation. There are more neuro-functional adaptive changes than structural changes within the muscle. Thus, strength is not solely a property of the muscle rather it is the property of the motor system.

Also, during the first weeks of strengthening exercises there is a reduction in the coactivation of other muscles (muscle synergies, pathological movements). It results in a decrease in energy expenditure, movement control improvement, and at the same time it leads to a decrease in mm spasticity (functional) resulting in functional improvement (or a great condition to achieve functional improvement).

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After 4 weeks of resistive training, gains in strength are gradually achieved by increased size of the muscles (hypertrophy). The initial neural contribution to increase strength diminishes. At this time we will not notice further dramatic changes to the neuro-motor system of the body. Changes will be more specific and related only to the musculo-skeletal system.

4. Intensive Exercise Methods

Resistive training can induce adaptive alternations in nervous system function, along with changes in the morphology and architecture of the trained muscles. Resistance training that results in both improved neural function and gains in muscle mass will benefit not only athletes, but also aged individuals and individuals with neuro-motor disorders. This will provide an effective way to improve everyday physical function.

These findings help us to explain the success of the new and popular intensive treatment programs for Cerebral Palsy (e.g. Suit Therapy). Very characteristic of these methods is the short time of duration (2-4 weeks) and high intensity of the exercises (volume, frequency, resistance).

During 2-4 weeks of intensive therapy sessions, young individuals with CP perform resistive exercises 3-4 hours per day, 5-6 days per week. Very often after this short period of treatment, these individuals present significant functional improvement. Based on the theory of strength development, the functional improvement occurring after a short period of strength training is related to motorneurological changes. In a short time individuals with CP improve movement control, balance and coordination. Often they are able to perform functional skills that they were not able to do before (sit, roll, walk). This improvement is caused by adaptive changes that occur in the nervous system in response to strength training. Electromyogram studies have indicated other adaptation mechanisms that may contribute to an increased efferent neuronal outflow with training, including increases in maximal firing frequency, increased excitability, decreased presynaptic inhibition of spinal motor neurons, and downregulation of inhibitory pathways. Short term resistance training has been reported also to induce hypertrophy of slow and fast muscle fibers, induce alternations in muscle fiber architecture and fiber type distribution, and other morphological changes.

Resistance training creates many other positive adaptive morpho-functional changes in other systems of the body (skeletal, cardiopulmonary, endocrine, etc.). More information about those changes are included in the bibliography recommended at the end of this article.

5. Summary

To summarize, strength training in CP results in strength gains that are similar to those seen in persons without a central nervous system lesion, and produce positive outcomes in motor performance and functional skills.

For many individuals with cerebral palsy, strengthening exercises are important for their well-being. It allows them to maintain physically active lifestyles and overcome daily barriers. For many others, the improvement in functional skills achieved secondary to strength training allows one to perform for the first time in life new activities never done before. Secondary to improvements in strength, some individuals become more independent in daily life.

I believe that all the information and facts presented here are convincing enough for parents and therapists to make it imperative to incorporate strengthening exercise programs in the life of each individual with cerebral palsy.

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About the author



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INTENSIVE EXERCISE PROGRAMS

PHYSIOLOGY BEHIND MIRACLES

By Richard Koscielny

INTRODUCTION

In recent years many parents and therapist had a chance to hear about or try one of the new intensive treatment methods. The term "Intensive Therapy" became very popular. To attract patients many programs claim that they provide intensive therapy, sometimes without the proper understanding of the essence and purpose of this approach.

During the preparation to write this article, I browsed for a few weeks through the internet and read many professional magazines and books. Here are some examples of intensive therapy programs:

- intensive manual therapy
- intensive suit therapy
- intensive aquatic therapy
- intensive physical therapy
- intensive neurodevelopmental therapy

I also reviewed a few studies comparing intensive regular therapy with other methods. I am happy that those studies were conducted, but at the same time sadly I have to admit that the methodology of those studies failed. Why? Because they were based on the wrong definition of an intensive exercise program and lacked the understanding of the real nature of cerebral palsy. My goal in this article is to present the idea of an intensive therapy program and the rationale behind it. I have to disclose that I personally promote an intensive exercise program. I am a therapist and personal fitness trainer. I own the Pediatric Fitness Center for children with cerebral palsy. Also, I am the parent of a 13 year old daughter with CP. In the last 2 years, together with my wife, we helped to train therapists and established more than 20 centers around the country that provide intensive exercise programs. The information provided in this article is based on more than 14 years of professional and personal knowledge and experience.

WHAT IS INTENSIVE THERAPY

For many practitioners, intensive therapy means a physical therapy session lasting for a few hours and provided on a daily basis for a few weeks. Unfortunately, this is an oversimplification of this approach. Simply increasing the amount of regular standard therapy does not guarantee results. The second approach practiced by many is the combination of many therapy methods during one session, very often in the same day. This also can be ineffective and I will explain why later.

In order to claim that a particular therapy is an intensive program, certain physiological principles and rules have to be applied.

Before I explain those principles, I have to clarify some basic definitions. In physical therapy we use the term treatment. To treat means to try to cure or alleviate as in disease Cerebral Palsy is not a disease. It is a condition. We cannot heal individuals with CP. We can work with symptoms not etiology. Through exercises, we can utilize to the maximum existing functional potential and create positive changes in the neurological/skeletal/muscle systems, but we will not heal or change the damaged structures (brain). I prefer to use the term exercise program instead of treatment. We have to remember that the physiology of individuals with CP is the same as those without CP. The body of a CP individual responds to exercises in a similar way like that of an individual without CP. It means that instead of using the medical term treatment, it is better to use terms like exercises or training.

The term intensive therapy simple means intensive exercise or training. In order for the training to be effective, there are a few principles to meet:

1. progressive overload
2. individuality
3. specificity
4. disuse
5. hard/easy
6. periodicity

All of those principles are based on human physiology and can be applied to disabled and nondisabled people. I don't want to explain all of those principles. However, it is important for any individual who wants to provide an intensive approach to know them before practicing. Without them, it will be impossible to design a safe and effective program.

The most important principle is **progressive overload**. The main purpose of an intensive program is to maximize the effect of intensive stimulation of all body systems. To induce those changes (increase strength, endurance, improve function, etc.), there has to be applied a certain level of stimulation (intensity). The level of stimulation has to be above threshold level. What it really means is that the intensity of performed exercises has to be high enough to induce a physiological response from our

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body. If during an exercise session the intensity is too low, there will be no adaptive changes and no progress.

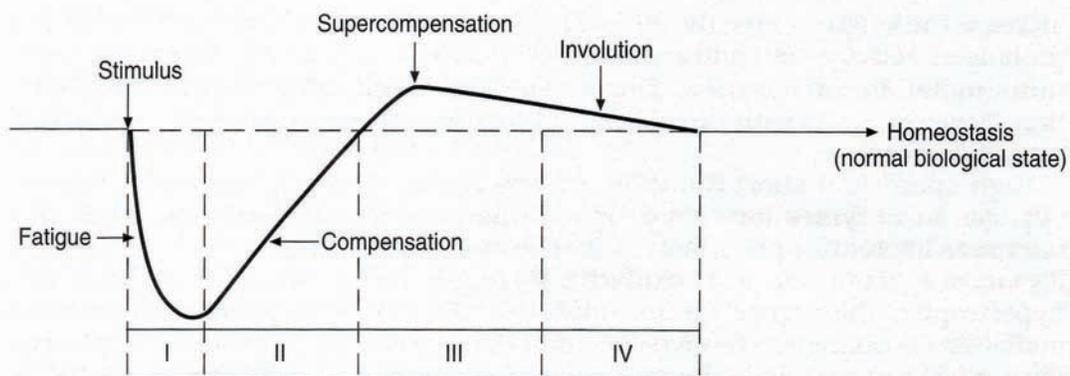
After undergoing intensive exercises the body experiences fatigue. In the following period our body rests. During the resting process all body systems are recovering. The body is anticipating the next exercise session and prepares all systems for the next stress. The lungs increase capacity to be able to intake more oxygen. Muscles become stronger to be able to work against higher resistance. There are more stored energy sources. This phase is called **supercompensation**. During the next exercise session an individual can work harder, longer, and is able to perform more complex tasks. This is called **adaptation**. During the next session we can apply even a higher stimulation (intensity) on the body. The response is further adaptation. In our case when working with individuals with CP, further adaptation can result in the ability to roll, sit and walk sometimes for the first time in their life.

Also of importance is the time of recovery. Usually the recovery period, including supercompensation, is 24 hours (Herberger 1977). Variations in supercompensation depend on the type and intensity of the exercises. For instance, after endurance exercises supercompensation may occur after 6 to 8 hours.

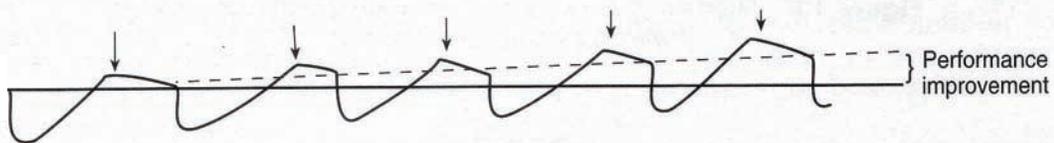
After an intensive session that places high demands on the CNS (Central Nervous System), it may take more than 24 hours, and occasionally even 48 hours. In order to achieve progress the next exercise session has to occur during supercompensation. If the rest period is too long, all the benefits from the supercompensation phase are decreasing and the body returns to its normal state.

Now we can understand why regular therapy sessions can not be effective in the current model (1 hour, 1-2 times per week). First, it does not apply enough stimulation to induce physiological responses. Second, the rest time between sessions is too long. We can also now understand why regular therapy even 3-4 hours per day will not give us the expected results. The intensity of the exercise session is not related to only one factor – length of session. There are many other elements characterizing the intensity of the exercises:

- length of rest periods between exercises
- number of exercises
- number of repetitions
- number of sets
- amount of resistance
- technical difficulties and complexity of exercises



Supercompensation cycle of training session (modified from Yakovlev 1967) (2)



The sum of training effect (adapted from Harre 1982) (2)

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Generally we can increase the intensity of the exercise session through an increase in volume (time and frequency) and muscle force (resistance training).

Utilizing those elements, we can modify and intensify each session to meet the requirements of the progressive overload principle.

To design an effective intensive exercise program for individuals with disabilities, it is necessary to combine the knowledge from a few disciplines. A good therapist has to know and understand how the body works, how to assess the influence of disabilities on functional potential, but also has to know how to train the body, what exercises to choose, and how to modify them. He/she has to work as a coach and trainer. I have found in recent physical therapy literature and magazines that many therapists understand this and support this approach.

RESULTS OF AN INTENSIVE PROGRAM

In recent years, mainly through the media and internet, many of us were able to gather information about significant progress noted as a result of intensive exercise programs. Many of those sources are anecdotal and not supported or confirmed by the medical society.

In reality the results of an intensive exercise program can vary depending on the program, severity of disabilities, and the exercise method and equipment used. The common observed improvements are: increased strength, endurance, balance, coordination, better functional skills, speech, cognition, decreased muscle tone, and better alignment of the body. Generally up to 90% of the children and teenagers undergoing intensive programs improve in strength and functional skills. To explain this please read the article in this issue on Strength Training for CP.

Does the improvement achieved during an intensive exercise program last long? What are the long-term effects of this approach?

Those are common questions from parents and professionals. I have to be honest. Intensive therapy is not a magic pill. It will not fix all the problems and the results will not last forever. Those positive changes can be maintained sometimes only for a few months.

Why?

Because as I mentioned before, we do not cure CP. We treat individuals with CP as nondisabled people. An able bodied person in order to improve his/her own fitness level or participate in a competition has to change his/her own life style. He goes to the gym a few times a week for a few months and changes nutritional habits. It improves his fitness condition. He is stronger, faster, more flexible and able to perform activities

never done before. Then he gave up. No more exercises. No maintenance program, no gym. Fast food. In a few months his body goes back to normal. He loses strength, flexibility, endurance, and all his new skills. His body's systems return to the level before exercises. If he chooses an even more sedentary life style, his body will deteriorate even more.

The same rules apply to individuals with CP.

For many individuals with CP to learn how to walk is like training to win a gold Olympic medal. If after achieving their goals they go back to the previous life style in a few months they will be back walking with a walker or sitting in the wheelchair. This is true about CP. This condition requires a lifetime management and constant exercises. Also, parents have to understand that in order to maintain the progress achieved during an intensive program, they have to commit their time and effort and continue the prescribed home exercise program. I have to admit based on my years of experience that this is the main factor why the results of intensive therapy do not last too long. There is also another important factor related to the short life span of the achieved progress. During exercises individuals learn new motor skills. The learning process of a new movement has a few phases. First we are receiving external information about movement (verbal description, visual presentation, observation). Then we try to repeat certain movements through activation of different muscles. Slowly through repetition and guidance we gain strength, balance, coordination, and learn how to perform the movement.

In this phase we have to constantly control the quality of the movement and think (control muscles). This phase is called **generalization**. It can occur after a few weeks of exercises. In the next phase after hundreds of repetitions, we are able to perform certain motor tasks without thinking. This phase is called **automatization**. For Cerebral Palsy individuals it can take thousands of repetitions, sometimes months or years, of exercises to reach this phase.

Because of the short duration (2-4 weeks), intensive exercise programs are able to reach only the generalization phase of motor learning. Skills learned during this phase do not last long if they are not repeated and reinforced.

Without a proper maintenance program provided by parents, school, or therapist, we cannot expect any long-term results. I am sure that this will answer and help to explain why intensive therapy research failed to prove the long-term effectiveness of this approach.

As a last word in this section, I would like to add that very often the results of intensive programs are enhanced by using special exercise equipment (e.g. Universal Exercise Unit, weights, fitness machines, different types of Suits: UpSuit, TheraSuit, Spiral Suit, Benik vest, splints, braces and other devices).

PHYSIOLOGY OF EXERCISES

SPECIAL CONSIDERATION

Many parents who look for new hope for their children face dilemmas with new alternative methods or programs to choose from. It's hard to make a decision that in consequences can cost thousands of dollars and when outcomes are uncertain. Before making any decisions I would advise you to do the homework. Find as much information as possible about the method. Start with the Internet. Visit web sites. Visit chat rooms and parents to parents e-mail groups. Call the facility providing the program. Ask for information, and ask somebody to explain the method. If you don't understand, ask again.

If somebody is not able to explain his/her program in clear simple language, it means that probably he/she does not fully understand what he/she does. Ask your therapist or physician about the method and outcomes. Being a parent and therapist, I look for one simple program, not a combination of many different methods at the same time. This is one of the current trends to attract more parents. I can agree to a combination of intensive exercises and manual therapy with other recreational activities and non-intensive approaches in the same day. Example: 3-4 hours of treatment in the morning and in the afternoon other activities like aquatics, horseback riding, and maybe also HBOT. It is important that the adjunctive methods being utilized are geared to the individual's specific condition and towards their goals. They should enhance the progress, not hinder it. Refer to page 18, the article on INRS to see an example of an intensive program with added methods that all complement each other with the individual's main goal in mind. But offering 6 or more hours of therapy per day including intensive exercises, sensory integration techniques, electromagnetic resonance therapy, biofeedback, oxygen, motorpoint stimulation, mud therapy, and massage in one day can be too much. It looks like somebody is trying to treat a headache by taking many different pills at the same time (Motrin, Tylenol, Advil, Aspirin). This approach can be too intensive and it can lead to overstimulation.

The patient will become too tired. The body does not have enough time to rest. The consequence is the supercompensation phase does not occur and there are no adaptive changes and expected progress. When the fatigue level cumulates, the body is more prone to injury. The patient can react negatively to treatment (uncooperative, crying). If someone claims that all methods offered by their facility help individuals with CP, it means that probably none of them are good enough. From the professional point of view, this kind of marketing of therapeutic service looks like advertising for a spa facility.

Another very important aspect of using a combination of a few methods in the same day is a possibility of counter actions and side effects. Example: Free radicals from low pressure hyperbaric oxygen treatment are not desired when applying electromagnetic resonance therapy. There are almost no studies showing which combination of treatment methods are safe or most effective.

My intention is not to scare or discourage parents. So far the intensive therapy provided in many facilities proved to be very safe and highly effective.

To summarize, I would like to encourage parents to try an intensive exercise program for their children. I advise therapists to learn more about it and practice it in their own clinics. For older individuals with CP, this approach could be a new door to achieve greater functional independence in their life.

However, intensive exercise programs show only short term effects. It is very encouraging that those effects occur and with proper management can be sustained. For many individuals frustrated with the lack of progress after years of therapy, this fast progress in a short time will give them hope for the future.

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