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Innovative Thinking of Inducing Passive Resistance Training and Demonstration of Abnormal Muscle Strength Techniques for Stroke Intervention

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Abstract

Background and Purpose: Usually resistance training can only be done in the active state. The difficulty of upper limb rehabilitation of stroke patients lies in the inability to complete resistance training on the antagonistic muscle groups with high muscle tension. The vast majority of stroke patients experience upper limb or arm extensor muscle weakness, and many lose the strength of their antagonistic muscle groups, preventing them from performing progressive resistance training, resulting in a large number of stroke patients with long-term upper limb disability. We took the lead in proposing induced passive resistance training to form passive resistance thinking and mode that activated antagonistic muscle groups in the upper limb of stroke, and selected stroke patients who were more than one year old and still had obvious flexion spasm in the upper limb as demonstration objects to observe the intervention effect of this method on abnormal muscle strength.

Methods: Functional acupuncture and passive resistance of upper extremity extensor group induced by Professor Yan Zhi were the main intervention methods. Implementation requirements are as follows: a) Selection of therapeutic positions. b) Selection of intervention site. c) Selection of strength and waveform. d) Real-time evaluation of intervention effects after intervention. e) Multi-task intervention training of upper limb extensor muscle group after treatment.

Results: After 20 minutes of intervention, flexor tension of upper limb, elbow joint, wrist joint and finger joint was improved obviously, extensor function of elbow and wrist joint was recovered obviously, elbow extension resistance function of left upper limb was recovered obviously.

After one month of the above intervention treatment, the abnormal muscle tone of the left upper limb of the patient was significantly reduced, the elbow extensor strength score was increased from 0 to 5, and the flexion spasm of the upper limb was significantly improved in multiple scenarios.

Conclusion: The demonstration of this method highlights the significance of three aspects: A) Patients with upper limb flexion spasm more than 1 year after stroke with this method showed obvious intervention effect immediately. b) To confirm that functional acupuncture and medium-frequency induced passive resistance training are the most effective methods for the intervention of abnormal muscle tone in the upper extremity. c) The control of intervention dose and the repetition of precise rehabilitation training have a positive effect on the improvement and continuation of the therapeutic effect.

Keywords: Passive resistance training; Abnormal muscle tone; Stroke

Introduction

Stroke is generally defined as a neurological loss caused by an abnormal perfusion of brain tissue. The most common types of stroke are intracerebral hemorrhage, subarachnoid hemorrhage, and ischemic (cerebral infarction) [1]. A recent projection from the American Heart Association (AHA) [2] indicated that, by 2030, 3.4 million people aged ≥18 years will have had a clinical diagnosis of stroke. These data deserve concern, once this disease is characterized by a poor prog nosis, from—at least—a marked impairment of functional capacity and cardiorespiratory fitness due to central and peripheral mechanisms until early death [3-5]. In fact, in 2013, stroke was the cause of 1 in every 20 deaths in the US, and every 40 seconds someone is affected by this disease [2].

Reports suggest 70% of individuals who have had a stroke experience upper limb or arm weakness with approximately 62% not regaining useful upper limb function at six months [6]. Positive engagement in high intensity and task specific rehabilitation has been recommended for physical and emotional recovery after stroke; [7, 8] however, issues such as cost and access often limit the dose of rehabilitation provided following hospital discharge.

Stroke is the second most common cause of death globally [9]. Although stroke incidence has declined over time, the overall stroke burden (ie, absolute number of people affected or disabled by stroke) has increased globally [10]. In the community as well as during inpatient rehabilitation, people with stroke typically achieve very low levels of any type of physical activity.

In an observational study by Alzahrani et al, [11] people with stroke living in the community were monitored to establish the amount of free-living physical activity that they undertook during the day. Compared with age-matched healthy peers, people with stroke spent similar amounts of time in physical activity but achieved about half as many activity counts.

The systematic review by de Sousa et al [12] was designed to find out if repetitive practice that is known to improve activity outcomes also improves strength after stroke. Most people with stroke have an extensive loss of strength [13] and in many people that loss of strength precludes the use of progessive resistance training as they do not have sufficient strength to move against gravity, let alone against resistance. However, they are generally able to do some form of repetitive practice of (modified) tasks. The pooled analysis in the review by de Sousa et al [12] showed that repetitive practice substantially improves strength after stroke. The authors hypothesise that one of the mechanisms for improved outcomes with repetitive practice is its ability to improve strength in addition to improvements in coordination of muscle activity.

The ultimate goal of shoulder rehabilitation is to return a person to maximal functional levels. The first objective in rehabilitation after surgery or injury is often to help the subject regain full active motion while giving consideration to his or her healing tissues. Healing animal tendons are reported to be 25% of their preinjury strength level at 12 weeks. [14] Health-care professionals often instruct patients to progress to active shoulder exercises as tolerated between 6 and 12 weeks after injury/surgery without specific knowledge about the shoulder muscular activation levels of the exercises. The loads applied during rehabilitation exercises must be tailored to progress along a continuum so as not to exceed biomechanical limits of healing tissues, yet still facilitate the alignment of newly formed collagen fibers in a functional pattern [15-17].

Electromyography (EMG) has been used to investigate various therapeutic exercises that maximally activate shoulder musculature, which provides valuable information for challenging shoulder musculature at greater levels of muscular activation intensity [18-20]. Studies in which the authors document specific muscular activation levels along a continuum assist clinicians to develop exercise progressions [21-23]. McCann et al [21] investigated the 3-phase Neer shoulder rehabilitation program and demonstrated that a progression from passive to active to resistive exercises increases muscular activation intensity as measured by EMG. Recognition of progression is valuable because it allows clinicians to modify programs up or down a level depending on a patient's response. Limited EMG information is known about rehabilitation exercises used in the early phases of rehabilitation progression when the clinician is balancing the goal of regaining motion while not overloading the musculature [21, 24].

The Neer exercise program is the one program with known activation levels, but other programs' muscular activation levels are unknown [25, 26]. One commonly used program initiates passive and active-assistive exercises in supine by the use of the noninvolved extremity to support the involved extremity to regain motion [26-28]. This support is reduced by use of a towel, and resistance is gradually increased by elevating the trunk from supine to vertical. This program [26] emphasized scapular protraction and active motions rather than isometric and elastic resistance exercises as in the Neer program [21]. Another approach incorporates the entire kinetic chain of the body to facilitate arm elevation and initially places the hand in contact with a support surface to unload the weight of the arm [25, 29-32].

The research team led by Professor Yan zhi believed that the main cause of loss of limb function and loss of resistance ability after stroke was muscle tension, and the side of muscle tension formed was mainly closely related to the intensity and frequency of daily use. They have made new progress in the clinical research of using functional acupuncture to intervene muscle tension. Many research teams in China have been devoted to the research and technical promotion of acupuncture in the treatment of diseases, and more and more domestic and foreign literature has added more evidence for the effectiveness of acupuncture in the treatment of diseases [33-36]. Targeted functional electroacupuncture is one of the most effective methods for non-surgical intervention of high muscle tension invented by Professor Yan Zhi in the course of clinical practice. Clinical studies have confirmed that targeted functional electroacupuncture has a strong nerve reflex activation effect on targeted muscle groups, and has an obvious and real-time effect on reducing muscle tension. The mechanism of functional electroacupuncture's intervention in muscle tension needs to be further studied [36]. Their application of functional acupuncture has achieved obvious results in the treatment of facial paralysis and upper eyelid ptosis [37-38].

Many literatures have reported the intervention effect of drugs, [39] functional electrical stimulation [40] and physical therapy [41] on the abnormal muscle tone after stroke. At the same time, the problems of general weakness caused by drugs, functional electrical stimulation and the reduction of tension caused by the patient's comfortable position during physical therapy have been puzzling physicians and therapists.

Professor Yan Zhi believed that in order to effectively and quickly restore the limb function of stroke patients, it was necessary to increase the sensitivity of antagonistic muscles to stimulation on the basis of the intervention of abnormal muscle tension, and to awaken and restore the resistance ability of antagonistic muscles in early hours. In the classification of patients' active exertion degree in exercise therapy, it can be divided into passive exercise, assisted active exercise, autonomous active exercise and resistance active exercise. It can be seen that resistance exercise is the ultimate goal of rehabilitation. Professor Yan Zhi has created a new therapy of intermediate frequency induced passive resistance training in the long-term clinical rehabilitation practice. New progress has been made in the research and application of intervention on abnormal muscle tone after stroke. For this reason, we selected a patient with a disease course of more than one year after stroke who still showed obvious flexion and spasm due to abnormal muscle tension. Functional acupuncture and intermediate frequency induced passive resistance training were adopted in the hospital for intervention demonstration of abnormal muscle tension, and significant curative effect was obtained within one week. The report is as follows:

Methods for intervention of abnormal muscle tone

Patients' muscular tension before intervention (Fig.1 and Fig. 2):

As can be seen in Figure 1 and Figure 2, the patient showed obvious elbow flexion >90^{o} in the left upper limb, obvious flexion of the wrist finger, and obvious adduction of the thumb while walking, and the patient could not induce the extension of the elbow, wrist, finger and thumb. For more than a year after the stroke, the left upper limb showed typical elbow flexion, wrist flexion, finger flexion, and thumb adduction, and the combined response was obvious. (Figure 1).

Figure 1.

Figure 2.

In the rapid intervention of functional acupuncture and intermediate frequency induced passive resistance training for abnormal muscle tone after stroke, the following five operational processes should be carried out:

1. The affected limb was placed in the passive state of shoulder extension, elbow extension, wrist extension and thumb abduction to achieve the maximum relaxation of the extensor muscle and the obvious effect of stretching the flexor muscle. At this time, the target extensor muscle group (triceps brachii, extensor digitalis longus and extensor hallucis longus) would be significantly contracted when electroacupuncture was performed (Fig.3) [36].

Figure 3.

2. Holding the position shown in Figure 3, select the target muscle group of the patient's upper limb to stimulate. For this patient, triceps, extensor and abductor thumb were selected muscles, with two needles inserted into the abdomen of each muscle group for optimal formation the effect of stimulation (Figure 4) [36].

Figure 4.

3. For the first 3 to 5 minutes of electrical stimulation, the upper limbs should be passively extended to avoid the needle bending after joint flexion. After 5 minutes, it can be observed that functional electroacupuncture has quickly and effectively solved the abnormal muscle tone of the upper limbs after stroke and significantly decreased (Figure 5).

Figure 5.

4. After 20 minutes of functional acupuncture treatment, the patient can immediately appear shoulder extension, elbow extension, wrist extension, finger extension and other movements, and the abnormal muscle tension causing the flexion of the patient's left upper limb can be effectively relieved. In order to consolidate the efficacy and continue to improve the sensitivity of triceps and extensor muscles, the passive resistance training was performed under the stimulation of mid-frequency. It should be noted that the skin contact site of the mid-frequency patch was roughly the same as the acupuncture site, and the stimulation selected the density wave. Take the wrist as an example when the dense wave stimulation occurs, the wrist and fingers will be extended for 5 seconds. At this time, the external force of the wrist and fingers will be kept in the passive resistance state of slightly flexion 20. (Fig. 6-9).

Figure 6.

Figure 7.


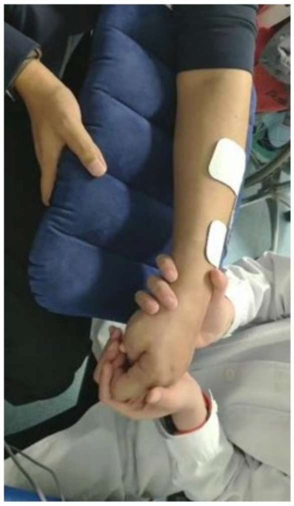

Figure 8. ***Figure 9.***

5. After 20 minutes of passive resistance training under medium frequency stimulation, we obtained the following results: 1) the tension causing flexion of the elbow on the affected side (biceps brachii) basically disappeared, the tension causing flexion of the finger and wrist (longus flexion and short flexion of the finger) basically disappeared, and the adduction tension of the thumb basically disappeared. 2) When the elbow was suddenly flexed after 5-10 times of 5-10º rapid expansion activities in the extension position of the affected upper limb, it was found that obvious resistance appeared at 30-60º to limit further elbow flexion, indicating that the treatment had awakened the sensitivity and resistance of the triceps. 3) At this time, patients can do 30-60º elastic band resistance training. (Fig.10, Fig.11) 4) In order to improve and consolidate the curative effect, it is necessary to strengthen the multi-task training which is easy to cause the joint reaction of the upper limbs, (Fig.12-17) and do 2) once in the morning and 3) once in the afternoon every day, with an interval of 1 hour.

Figure 10: Resistance elbow extension training.

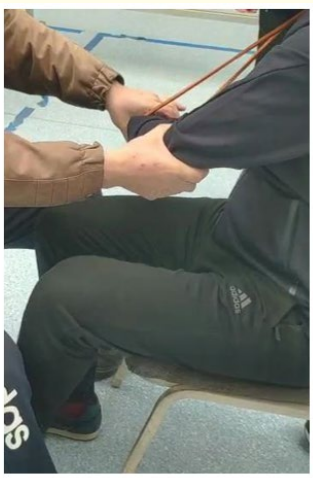

Figure 11: Seat step resistance elbow extension training.

Figure 12: Seated resistance to stampede training.

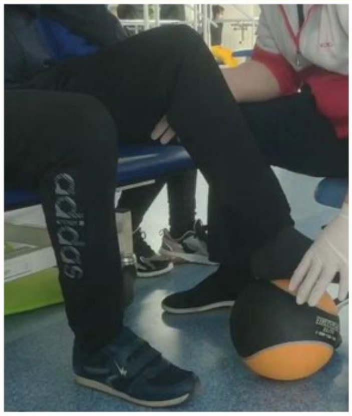

Figure 13: Sitting ball control drills.

Figure 14: When walking, the self controls the affected limb behind the elbow, wrist and fingers.

Figure 15, 16: Pushing interferes with elbow extension training when walking down.

Figure 17: Fast walking training (passive elbow, wrist and finger extension).

Results

After one week of training, the abnormal muscle tone of the patient's left upper limb significantly decreased, the muscle strength rating of the elbow extension increased from 0 to 5, and the patient showed obvious elbow extension control ability (Fig.18, Fig.19).

Figure 18, 19: One week later, the muscle tone in the left upper limb was significantly reduced discuss.

Discussion and Conclusion

Discussion

Status of upper limb rehabilitation after stroke

The design of effective resistance training plan is a highly valuable training which must be paid attention to improve the athletic level of athletes, and also a way of exercise for the general public to improve the quality of life. In the process of designing the resistance training plan, the effectiveness of the plan for the object training should be fully considered. Resistance training plan contains many factors (practice style, number of sets and repetitions, interval time, movement speed, etc.). All variables must be carefully considered in the design process. There is no perfect training plan in training.

The prognosis of lower limb rehabilitation is better than that of upper limb rehabilitation for stroke rehabilitation expectation, At 6 months post-stroke only 5-20% achieve full return of arm function [40, 41]. There is a time-limited period of unique neuroplasticity post ischemic stroke that lasts about one to 3 months in humans. This plasticity mediates spontaneous biological recovery and produces enhanced responsiveness to rehabilitative interventions introduced during that time [42]. It is believed that during this time of unique plasticity, impairment based recovery is maximal and is mediated from both of these related processes - spontaneous recovery and enhanced responsiveness to training [42]. Spasticity occurs in 4-42.6% of patients after stroke and can cause disability, pain, and secondary complications such as impaired movement and joint contracture, thereby reducing quality of life and increasing the burden of caregivers [43, 44]. Botulinum toxin type A (BTX-A) is commonly administered to patients with post-stroke upper limb spasticity 45and has been proven to be safe and effective [45, 46].

Effective management is important for patients with upper limb spasticity after stroke because spasticity and abnormal postures cause discomfort for patients, difficulties for caregivers, and ultimately reduced quality of life [47, 48] Treatment methods for spasticity include physical therapy, electrical stimulation, oral antispastic medications, neuromuscular blockade with phenol or alcohol and botulinum toxin, and surgical treatment [48]. While oral antispastic drugs are considered for generalized spasticity, side effects such as sedation, drowsiness, dizziness, weakness, and confusion frequently occur. Patients with focal spasticity are usually injected with intramuscular botulinum toxin, [48] which inhibits the secretion of acetylcholine from the presynaptic endplate acting on the neuromuscular junction, thereby lowering muscle tone and relieving spasticity after stroke [49]. For example, a 2014 meta-analysis found a positive relationship between increased therapy time and clinical measures of function and impairment overall [50].

Mechanisms of neuroplasticity such as the formation of new synaptic connections with concomitant modification in the cortical excitability and somatotopic remapping can be positively influenced by training methods that are developed from established principles of motor learning [51-53]. Topographic patterns of reorganization of the corticospinal system can be quantified using TMS induced motor evoked potentials (MEPs) to assay the integrity of the sensorimotor cortex representation of arm and hand muscles [53-56]. Although some studies using TMS mapping to track ipsilesional motor reorganization over the first months to 1 year following stroke have indicated that increased excitable areas in the ipsilesional hemisphere are associated with recovery of the upper limb, [57, 58] other studies have found no change in ipsilesional excitable area over the same period [59, 60].

Six months after the stroke, only a small number of patients fully recovered upper extremity function [61, 62]. There is a unique Neuroplasticity time-limited period after ischemic stroke, lasting approximately 1 to 3 months in humans. This plasticity mediates spontaneous biological recovery and generates a stronger response to rehabilitation interventions introduced during this period [63]. For example, a 2014 meta-analysis found a positive correlation between increased duration of treatment and clinical measures of overall function and impairment [64]. Mechanisms of Neuroplasticity, such as the formation of new synaptic connections, along with modifications in cortical excitability and postural repainting, can be positively influenced by training methods developed from established principles of motor learning [65, 66]. Topographic patterns of corticospinal system reorganization can be used to determine the integrity of sensorimotor cortical characterization of arm and hand muscles using TMS-induced motor evoked potentials (MEPs). Although some studies using TMS mapping to track ipsilateral motor reorganization in the first months to 1 year after stroke have shown that increased excitable areas in the ipsilateral hemisphere are associated with upper limb recovery, but other [67-70] studies found no change in ipsilateral excitable regions during the same period [71, 72].

A new idea of upper limb rehabilitation for apoplexy patients and an innovative rehabilitation method are proposed

A long-term clinical study on the correlation between stroke rehabilitation program and curative effect found that the dystonia of flexor muscle was the main reason for the difficulty of upper limb function rehabilitation in most stroke patients. We think that as long as there is tension, there is muscle-nerve coupling. We hypothesized that increased tension on one side of the upper extremity (flexor spasticity of the upper extremity occurs in most stroke patients) is due to perennial flexion resistance activity that is much greater than that of the extensor, resulting in higher neuromuscular sensitivity than that of the extensor. Therefore, the inertia of the limbs after a stroke appears as flexion. Therefore, the inertia of the limbs is manifested as poststroke flexion. In clinical rehabilitation, there is no special awakening method, so flexor strength training combined with other exercises, further increase the flexor-extensor strength gap. Therefore, Professor Yan Zhi proposed triceps targeting rehabilitation thought and method:

1. Stop overtraining the flexor side of the upper extremity in stroke patients and intervene if necessary (this will be discussed in a later article).
2. In order to improve the sensitivity of the extensor muscles of the upper limbs to stimulation, the functional acupuncture we used has an immediate effect on the targeted enhancement of the muscle sensitivity. The feature of functional acupuncture is to ignore the injection of meridians and acupoints, and select the target muscle (mainly the antagonistic muscle corresponding to the abnormal muscular tension of stroke patients) that can stop the symptoms immediately as the target muscle of acupuncture [36].
3. Passive resistance training induced by intermediate frequency signals can awaken and stimulate the resistance of antagonistic muscles in a short time after increasing their sensitivity to stimulation.
4. Because you can't stop the rest of the body from doing the upper-extremity rehabilitation, the rest of the body's training can counteract the upper-extremity rehabilitation because of the combined effect, this kind of contradiction can affect the progress and effect of upper limb rehabilitation. For this reason, Professor Yan Zhi proposed that in other exercises that can cause the joint reaction of the upper limbs, the upper limbs should be held in a 5-10 backward extension position with the elbow in the largest backward extension position, the carpal knuckle is at 90% maximum extension. This can effectively interfere with other training

brought about by the reduction of upper limb rehabilitation results, but also accelerate the rehabilitation of upper limb function.

Research Restrictions and Suggestions

In the study of stroke rehabilitation technology, we found that disordered and out-of-control neural reflex (mostly manifested as joint response in clinical practice) is the key to the upper and lower limb rehabilitation. Professor Yan Zhi took the lead in putting forward the new mode of passive resistance training in stroke limb functional rehabilitation. The core thinking of the technology is as follows:

1. Functional acupuncture (the applicable technology created by Professor Yan Zhi) should be used first to improve the nerve sensitivity of targeted muscle groups. Example 1: When non-drug intervention is required for upper limb flexion and spasm of stroke patients, rapid improvement of the strength of upper limb extensor muscle group is the most correct choice. However, due to the inefficiency of the method in the actual rehabilitation process, the rehabilitation effect cannot reach the expectation quickly. This will affect the patient's recovery confidence and later recovery compliance.
2. When functional electrical stimulation can cause the affected limb to extend elbow, wrist and finger obviously, the stimulation of functional acupuncture can be reduced or stopped, and passive resistance training can be started. The key points of the technique are as follows: when using functional electrical stimulation (mostly using low frequency) to stimulate the upper extremity extensor muscle group, the extension of elbow, wrist and finger caused by the stimulation is restricted by external force, forming the passive resistance mode of the upper extremity extensor muscle group, and completing the technical preparation for rapid intervention of upper limb flexion.
3. The innovative thinking and techniques of limb rehabilitation for stroke patients reported here are influenced by such factors as patients' willingness to participate in experiments with new technologies, the degree to which all participants grasp technologies, and the measurement of treatment. Analysis and comparison of multiple outcome measures (tension, co-response, neurophysiology, functional MRI, short-term and long-term assessment, etc.) in patient populations are still not supported by the data, and therefore need to expand the case to obtain data support.

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Ethical Approval

The Human Ethics Committee of the Dalian Port Hospital and The Human Ethics Committee of the Affiliated Sichuan Provincial Rehabilitation Hospital of Chengdu University of Traditional Chinese Medicine the University approved this study. Participants give written informed consent before data collection begins.

Competitive interest

None. The Innovative thinking of inducing passive resistance training Ethics Committee(s) approved this study. All participants gave written informed consent before data collection began.

Abbreviated Title

Passive Resistance Training and Abnormal for Stroke.

Competitive interest

Nil.

Confirm

7.

Source

Uninvited.

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