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Stroke Rehabilitation in China Today

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Abstract

Background: Rehabilitation is cornerstone for the recovery of stroke patients. This lecture focuses on the current status of stroke rehabilitation in China.

Methods: Selective review of papers published by Chinese authors.

Results: A new system which is called "standardized tertiary rehabilitation" was established in China and has better effect on the recovery of motor function, cognitive function, ADL, LOQ, et al. Many novel therapies for motor rehabilitation after stroke has been used in China, such as motor imagery practice, repetitive transcranial magnetic stimulation virtual reality technique, mirror therapy, robotic therapy, et al. For balance training, sling exercises have been used. Electromyographic biofeedback, Catheter balloon dilatation, motor imagery therapy has been used to treat patients with dysphagia. Acupuncture treatment seems to be relatively safe and is widely used in China for stroke rehabilitation, but the evidence for the effectiveness of acupuncture for stroke was inconclusive, mainly due to poor methodological quality and small samples.

Conclusions: "Standardized tertiary rehabilitation" is a suitable rehabilitative care system in China. Almost all novel therapies for stroke rehabilitation have been used in China and acupuncture is a specific feature therapy.

Keywords: Stroke; Rehabilitation; China; Acupuncture

Introduction

Stroke is the leading cause of adult disabilities in China as in other countries. Every year in China, 2,000,000 persons experience first stroke and about 70%-80% patients cannot live independently [1]. In individuals aged 65+, the prevalence of self-reported stroke ranged between 6% and 9% urban China, but was much lower in rural site in China (1.6%). The proportion of stroke survivors needing care was higher in rural China (44%), urban China (54%) [2].

The common deficits associated with stroke are motor impairment (including limb spasticity), sensory impairment, language impairment (aphasia and/or dysarthria), dysphagia, cognitive impairment, visual impairment, and poststroke depression [3]. The most common and widely recognized impairment caused by stroke is motor impairment, which typically affects the control of movement of the face, arm and leg of one side of the body and affects 80% of patients to varying degrees. The focus of stroke rehabilitation is largely on the recovery of impaired movement and function in an effort to reduce disability and encourage participation in everyday activities [4].

Rehabilitation is cornerstone for the recovery of stroke patients. This article focuses on the current status of stroke rehabilitation in China. Most articles were published in Chinese rehabilitation journals and only controlled studies were selected. The aim of this article is to introduce advanced techniques used in stroke rehabilitation in China today and will provide :(1) Systems of (post-acute) rehabilitative care; (2) The recovery of motor function; (3) The recovery of dysphagia; (4) The recovery of incontinence; (5) Overall effect of Acupuncture on stroke patients.

Systems of (Post-Acute) Rehabilitative Care

There are many different systems of care that provide rehabilitation to patients after stroke. Organised stroke unit care is provided by multidisciplinary teams that exclusively manage stroke patients in a ward dedicated to stroke patients, with a mobile stroke team or within a generic disability service (mixed rehabilitation ward). In a recent review, Stroke Unit Trialists' Collaboration indicated that in stroke patients who receive organized inpatient care in a stroke unit are more likely to be alive, independent, and living at home one year after the stroke. The benefits were most apparent in units based in a discrete ward and no systematic increase in the length of inpatient stay [5]. Although the benefit of stroke unit has been proved in many studies [5-7], stroke units in China are only established in some big hospitals.

Acute rehabilitation is recommended by Chinese health administration in recent years, therapists were sent to neurological department for early mobilization and/or sitting balance training, but there are no high-quality articles in researching the effect of early stroke rehabilitation.

In recent years, a new system which is called "standardized tertiary rehabilitation" was established in China. The whole rehabilitation course of stroke is divided into three stages: the first stage is called early rehabilitation, which is carried on in neurologic wards and the patients are in Brunnstrum 1 and 2 stages; the second stage is called middle rehabilitation, which is carried on in rehabilitation wards and the patients are in Brunnstrum 3 to 5 stages; the third stage is called later rehabilitation, which is carried on in CBR and the patients are in Brunnstrum 5 and 6 stages. Many studies have showed that this rehabilitation system has better effect on the recovery of motor function, cognitive function, ADL, LOQ, et al. It is also an economical strategy for stroke rehabilitation [8-10].

The Recovery of Motor Function

The rehabilitation of walking

Gait recovery is a major objective in the rehabilitation of patients who experience stroke. A wide range of walking ability is present in patients after stroke that is dependent upon the severity of sensorimotor impairment. After stroke, 50% of patients initially are unable to walk, 12% can walk with assistance, and 37% can walk independently. At the end of 11 weeks of stroke rehabilitation, 18% of patients still are unable to walk, 11% can walk with assistance, and 50% can walk independently [11,12].

In China, all neuro-developmental techniques were used, such as PNF, Brunnstrom, Bobath, Roods, et al. In our experience, these techniques are all about equally effective. The favored techniques for gait training today in China are as follows.

Task-specific training: Tasks-specific training in rehabilitation focuses on improvement of performance in functional tasks through goal-directed practice and repetition. The focus is on training of functional tasks rather than impairment, such as with muscle strengthening. There is mounting evidence of the value of task-specific training as a neuromotor intervention in neurological rehabilitation. The evidence is founded in the psychology of motor skill learning and in the neuroscience of experience dependent and learning-dependent neural plastic changes in the brain in animals and humans [13].

This approach is increasingly being used in addition to conventional therapeutic approaches: i.e., the motor task to be learned must be practiced by repeating it as many times as possible. Task-specific training has also showed more effectiveness comparing with conventional therapy in Chinese studies [14,15].

Virtual reality: Virtual reality (VR) and interactive video gaming are new types of therapy being provided to people after having a stroke. The therapy involves using computer-based programs that are designed to simulate real life objects and events. The VR has the ability to create an interactive and motivational environment, which can be manipulated by the therapist to create individualized treatments [16-18]. Virtual reality programs are often designed to be more interesting and enjoyable than traditional therapy tasks, thereby encouraging higher numbers of repetitions and enhancing the patients' participation.

Mirelman et al. evaluate gait biomechanics after training with a virtual reality (VR) system and to elucidate underlying mechanisms that contributed to the observed functional improvement in gait speed and distance. The result showed that Subjects in the VR group demonstrated a significantly larger increase in ankle power generation at push-off as a result of training (p=0.036). The VR group had greater change in ankle ROM posttraining (19.5%) as compared to the NVR group (3.3%). Significant differences were found in knee ROM on the affected side during stance and swing, with greater change in the VR group [19]. In a latest review, Moreira et al suggested that VR is a promising method to improve the gait of patients with stroke. Nevertheless, some questions still need to be answered. Some aspects should be investigated to confirm the true benefits and application of VR in this population [20].

Few studies investigated the effect of VR on walking abilities in China. Xiang Xiao et al. investigated the gait parameters improvement in stroke patients after virtual reality with synchronized body weight support treadmill training (VR+BWSTT) [21]. The parameters of gait velocity and single-support-time asymmetry ratio changed significantly in experiment and control groups after treatment. The step length asymmetry ratio and maximum hip extension angle changed significantly only in experiment group. Those in control group displayed greater increase in maximum knee extension angle. Application of VR with synchronized BWSTT is effective in establishing symmetric and efficient gait in patients after stroke, especially effective in improving step length symmetry and hip extension.

Motor imagery practice: Motor imagery (MI) is the mental representation of movement without any body movement. Motor imagery practice refers specifically to the mental rehearsal of MI contents with the goal of improving motor performance [22].

Mental practice with motor imagery provides an opportunity to improve locomotor skills through safe and self-paced locomotor training in people with severe disability that renders walking practice difficult and limited in time, especially in the early phase of rehabilitation. Locomotor imagery training may be beneficial for patients who are unable to participate in physical gait training secondary to fatigue, severe paralysis or impaired balance. The benefit of MI on gait abilities have been shown in many studies [23-26].

We investigated the effect of motor imagery therapy on lower extremity function in stroke patients with hemiplegia Thirty hemiplegic patients meeting the eligible criterions were randomly divided into two groups : a treatment group (n=13) and a control group (n=17) [27]. All subjects accepted conventional rehabilitative treatment. Patients in treatment group were treated with motor imagery therapy after physical training, while the patients in control group were treated with physical training only. Motor function was measured by the percentages of changes in maximum loading (PL%) on affected lower limb, 5 m maximum back and forth walking speed (5m MBFWS), Berg balance scale (BBS), Fugl-Meyer motor assessment (10wer limb) (FMA-L) before the beginning of training and at the end of six week training. In both groups, all measurements at the end of training improved significantly (P<0.01) compared to that at the beginning of training. After the whole training course, PL% and 5m MBFWS (ms) in treatment group were significantly better compared to those in control group (P<0.05) and the other measurements were not statistically significant between two groups (P>0.05). Motor imagery therapy had positive effect on hemiplegia lower extremity function of sub-acute stroke patients.

Xu et al. also investigated the effect of MI on gait and walking ability rehabilitation in stroke patients. The results showed that MI is helpful for the enhancement of walking ability and gait stability in patients after stroke. Improvement was mainly in temporal-distance gait variables and gait asymmetry [28].

Intensive training: Integrating a large number of studies, it was found that intensive training was often described in two ways, which were "increasing training time" and "improving training intensity". The former one usually involves "extra work", "total training time", and the latter often refers to "training rate" [29]. Many studies have found that intensive training could improve recovery of motor function faster [30-32].

We investigated the effects of different intensities of lower limb training on the recovery of walking function after stroke [33]. Thirty six stroke hemiplegia patients who met the enrolling criterion were chosen and randomly divided into group A, B and C according to their daily training time. Patients in group A, B, C received training for 40 minutes, 80 minutes and 120 minutes per day respectively, five days per week, for a period of 4 weeks. The results showed that intensive training could accelerate the recovery of walking function of stroke patients.

Functional electrical stimulation for patients with drop foot: An estimated 20% of all stroke survivors experience foot drop, a consequence of spastic hemiparesis from stroke [34]. Foot drop, typically because of a combination of weakness of the ankle dorsiflexor muscles (agonists) and spasticity of the plantar flexor muscles (antagonists), results in a slower, less efficient gait and increases the risk of falls [35].

Although the effect of functional electrical stimulation to foot drop after stroke has been proved in many studies [35,36], the effect of FES is equivalent to the AFO [37,38].

In china, Meng et al. observed the effects of functional electrical stimulation assisted walking device (FES-AWD) on gait temporal-spatial parameters in stroke patients with foot drop [39]. Based on routine medical treatment and rehabilitation therapy, 9 stroke patients with foot drop received FES-AWD (GYKF-I) on affected side twice a day, 20 minutes per time， 5 days per week， for 4 weeks. All patients received 3-D gait analysis both with and without GYKF-I for three times : before treatment， one week and four weeks after treatment. The result showed : ①. There was no significant difference between free walk and walk with GYKF-I (power off) ②. In all three times visits， contrasting to free walk， walk with GYKF-I (power on) can significantly improve gait temporal-spatial parameters of the stroke patients with foot drop.

Shan et al. also explored the effects of gait triggered functional electrical stimulation on the temporal-spatial parameters of gait in foot drop patients after stroke through gait analysis [40]． The results showed that gait triggered functional electrical stimulation can improve the temporal-spatial parameters of gait such as walking velocity, cadence， gait cadence of foot-drop patients after stroke.

Robot-assisted therapy for gait function: A robot is defined as a re-programmable, multi-functional manipulator designed to move material, parts, or specialized devices through variable programmed motions to accomplish a task [41]. The most important advantage of using robot technology in rehabilitation intervention is the ability to deliver high-dosage and high-intensity training [42]. There are two types of robot for gait training: end-effector-type robotic devices and exoskeleton-type robot devices, both devices showed similar or additive effects relative to conventional therapy in patients with chronic stroke [43].

In China, only exoskeleton-type robot devices were used. Zhao et al. investigate the effect of Lokomat gait training rehabilitation robot on joint motion and lower limb function in hemiplegic patients after stroke [44]． The robotic group received robotic rehabilitation therapy in addition to routine rehabilitation training， while the control group was only given instructions for routine rehabilitation training. The Lokomat gait training rehabilitation robot can improve the lower extremities functions， as indicated by increase of ROM and muscle strength as well as decrease in muscle spasticity in hemiplegic patients after stroke.

Similar results were also found in their anther two studies [45,46].

The rehabilitation of arm and hand function

Physiotherapists try to train the patient's returning arm and hand: Function with repetitive practice, paying special attention to strength, coordination, and speed, and to integrate hand function into the patient's everyday activities. Some special techniques have been used in China.

Constraint-induced movement therapy (CIMT): CIMT is a physical rehabilitation technique that has attracted considerable attention as a means of treating the more-affected upper extremity and overcome learned non-use phenomenon following stroke [47,48]. CIMT involves the restraint of the less-affected upper extremity over an extended period, in combination with intensive task-related training of the more-affected limb [49]. The CIMT treatment regimen proposed by Taub & Uswatte has 3 components [50]: (i) a repetitive, task-oriented training of the impaired extremity or function following shaping principles for several hours a day for 10 or 15 consecutive weekdays (depending on the severity of the initial deficit); (ii) constraining the patients to use the impaired extremity or function during waking hours over the course of the treatment, sometimes by restraining the unpaired extremity; and (iii) applying a package of behavioural methods designed to transfer gains made in the clinical setting to the real world.

Li et al. explored the rehabilitation effect of shaping in constraint-induced movement therapy (CIMT) on motor function of upper extremity (UE) in chronic stroke patients [51]. Thirty chronic stroke patients, randomly divided into 3 groups: CIMT group (CI group), shaping group and occupational therapy group(OT group), 10 cases in each. Efficacy of shaping is similar to that of OT on UE motor ability, but CIMT can improve motor ability of UE significantly and can keep the effect until post-treatment 12 months by shaping applied with behavior technique together. The rehabilitation effect of behavior technique in treatments for stroke patients should be emphasized.

We compared the effects of 4 weeks of intervention using conventional rehabilitation, intensive conventional rehabilitation and modified constraint-induced movement therapy on the hemiplegic upper extremity in stroke patients [52]. Thirty stroke patient were randomly divided into 3 groups: conventional rehabilitation, intensive conventional rehabilitation, and modified constraint-induced movement therapy (10 individuals in each). Motor function was assessed using the Wolf Motor Function Test before treatment, and 2 weeks and 4 weeks after treatment.

Compared with classical intervention, modified constraint-induced movement therapy showed an apparent advantage over both conventional intervention and intensive conventional rehabilitation for patients after stroke.

Repetitive transcranial magnetic stimulation (rTMS): rTMS is a noninvasive method that can change the excitability of the human cortex for at least several minutes. TMS of the primary motor cortex (M1) activates corticospinal neurons trans-synaptically, eliciting volleys of neuronal output in the form of motor evoked potentials (MEP). It can also be used to study mixed populations of inhibitory and excitatory interneurons of various motor and nonmotor cortical regions within and across cerebral hemispheres [53]. The effect of rTMS on the function of upper limb after stroke has been proved in many studies [54-56].

In China, Shen et al. compared the effect of repetitive transcranial magnetic stimulation (rTMS) with different frequencies for upper limb function in patients with cerebral infarction [57]. The results showed that rTMS on the unaffected hemisphere of patients with cerebral infarction could improve the excitability of motor cortex of affected brain area and promote the recovery of upper limb function. Compared with 1 Hz and 2 Hz, 0.5 Hz could provide the most effective treatment.

Functional electrical stimulation (FES): Stroke patients are often unable to practice arm movements due to impaired motor control. Functional electrical stimulation (FES) addresses this problem, providing the experience of moving as well as improving upper limb motor control [58]. Recent studies have shown that when stimulation is associated with a voluntary attempt to move the limb, improvement is enhanced [59,60].

In China, Lin et al. investigated the long-term efficacy of FES in the recovery of upper limbs [61]. The FES group received FES on the affected supraspinatus muscle, deltoid muscle and extensor of wrist through surface electrodes. The intensity of stimulation current was set to produce full shoulder abduction and wrist extension with a duty cycle of 5 s on and 5 s off. The results showed that three weeks of FES to the affected upper extremities of subjects with early stroke improved their upper limb function and the efficacy could last for 6 months at least.

Motor imagery (MI) Practice: MI has been used more frequently in upper limb recovery after stroke. Although several studies have shown support for the notion that mental practice can reduce upper-limb impairments and increase functional use of the affected limb, none of the studies investigated whether mental practice promotes return to occupational performance as perceived by the participants engaged in the treatment [62].

The efficacy of MI and MI combined with biofeedback was also compared. Xie et al. divided 80 stroke patients into a MI group and MI combined with biofeedback group [63]. After 6 weeks of treatment the two groups had significantly higher mean EMG values, FMA scores and MBI scores, but the effects in the combination group were significantly better than those in the simple movement imagination group.

We explored the effects of mental practice on upper extremity function after stroke [64] Thirty sub-acute stroke patients were randomly divided into a treatment group (n=15) and a control group (n=15). The patients in the control group were treated with conventional therapy. The patients in the treatment group were treated with motor imagery therapy in addition. The results showed that mental practice can improve the functional performance of the upper extremities of stroke patients.

Virtual reality technique: This technique has also been used in upper limb recovery. In a recent review, Saposni et al. indicated that VR and video game applications are novel and potentially useful technologies that can be combined with conventional rehabilitation for upper arm improvement after stroke [18].

Liang et al. observed the effect of virtual kitchen upper extremities training combined with traditional occupational therapy on hemiplegic upper extremities function of stroke patients in convalescent phase [65]. Thirty-three stroke patients with hemiplegic upper extremities dysfunction were divided into therapy group (n=16) and control group (n=17). The patients in control group accepted traditional occupational therapy, 40 min/d, 5d/week for 3 weeks. The patients in therapy group accepted virtual kitchen upper extremities training and traditional occupational therapy. Virtual kitchen upper extremities training combined with traditional occupational therapy may be more effective on improvement of hemiplegic upper extremities motor function and ability of activities of daily living in stroke patients in convalescent phase.

Mirror therapy: Mirror Therapy (MT) or Mirror Visual Feedback is a relatively new approach in rehabilitation used in different neurological disorders, including stroke. During MT, the patient sits in front of a mirror that is oriented parallel to his midline blocking the view of the patient onto his affected arm. When looking into the mirror, the patient sees his unaffected arm positioned as the affected arm. By this, the patient gets the impression that actions upon his unaffected arm take place in his affected arm. This visual illusion seems to activate specific brain areas that might have a positive effect on motor and sensory recovery [66]. When compared with all other interventions, mirror therapy was found to have a significant effect on motor function of upper limb [66,67].

This approach has been used in China in recent years, also combined with conventional therapy. Zhou et al explored the effect of mirror therapy combined with task-oriented training on the upper extremity function of post-stroke patients [68]. Twenty-one post-stroke patients were randomly assigned to a treatment group (10 patients) or a control group (11 patients). The patients in the treatment group were given conventional rehabilitation therapy and mirror therapy in conjunction with task-oriented training for 4 weeks. Implementing mirror therapy in conjunction with task-oriented training is efficacious. It may promote upper-extremity motor ability in patients with hemiparesis soon after stroke, but there is no definite improvement in ADL abilities.

Bilateral training: Bilateral training has been investigated as a potential rehabilitation intervention, although to a lesser extent than CIMT. Bilateral training is a nonspecific phrase for a number of different training techniques which use both limbs to complete a task. According to the current literature, possible mechanisms underlying improvement from bilateral training include recruitment of the ipsilateral corticospinal pathways, increased control from the contralesional hemisphere and normalizationof inhibitory mechanisms [69]. However, studies have not demonstrated improvements in all patients using current outcome measures [70]. The effectiveness of bilateral training seems to be similar to usual care and other therapeutic interventions [71].

Zhen et al. investigated the effect of bilateral upper extremities training on upper extremity function of stroke patients in convalescent phase with moderate to severe upper extremity impairment [72]. Subjects in the bilateral training group practiced bilateral upper extremities rhythmic repetitive activities, and the control group performed conventional upper extremities training, mainly affected upper extremity unilateral training. Results showed that the bilateral upper extremities training may be more effective for improving motor function of affected upper extremity, especially for proximal upper extremity.

Intensive training: Although, there is strong evidence that early augmented exercise therapy time (expressed as time dedicated to practice) may enhance functional recovery, there is a discrepancy between the evidence for the benefits of intensive practice [29,73,74], this may be due to different augmented time.

We investigated the effects of different intensities of arm rehabilitation training on the functional recovery of hemiplegic upper extremity [75]. Thirty-two stroke patients meeting the enrolment criteria were randomly divided into three groups: group A (n=11), group B (n=10) and group C (n=11). Each group received arm training for 1 hour, 2 hours and 3 hours a day respectively, 5 days per week, for a period of six weeks. In each group, Fugl-Meyer Assessment, Action Research Arm Test and Barthel Index scores increased significantly after six weeks of treatment ($P<0.05$). An increase in the intensity of arm training might improve the motor function of the arm after stroke.

Balance training

Balance is an essential part of all functional activities during sitting and standing. A majority of stroke survivors have impaired balance and increased risk of falling toward the paretic side restricting functional abilities. Previous studies have shown that impaired balance was significantly correlated with length of hospital stay in inpatient rehabilitation facilities, locomotor function, and functional abilities after stroke [76,77]. Therefore, effective therapeutic interventions for improving balance function are suggested as an integral part of each person's rehabilitation plan after stroke. Researches in China focus on two strategies in balance training.

Core muscle training: Particular attention has been paid to the core because it serves as the centre of the functional kinetic chain. The core is seen as a muscular corset that works as a unit to stabilize the body and in particular the spine, both with and without limb movement [78]. Liemohn et al. defined core stability as "the functional integration of the passive spinal column, active spinal muscles and the neural control unit in a manner that allows the individual to maintain the intervertebral neutral zones within physiological limits, while performing activities of daily living" [79]. Core strengthening has been promoted as a preventive regimen, as a form of rehabilitation, and as a performance enhancing program for various lumbar spine and musculoskeletal injuries [80]. There are no controlled studies for the effect of core strengthening on stroke patients in other countries.

Sling exercises are designed to help strengthen the core muscles. An sling is comprised of a nylon support that you attach to a pull up bar. Fu et al. used sling exercises added to conventional therapy for balance training, results showed this therapy can improve balance ability after stroke assessed by Berg balance scale [81].

Biofeedback for training balance: Providing individuals with additional sensory information on their own motion, i.e. biofeedback, during training may enhance movement performance. Indications for added effectiveness of applying biofeedback during training of balance, gait, or sit-to-stand transfers in older patients post-stroke were identified for training-specific aspects [76].

Ye et al. investigated the effects of biofeedback-assisted performance on balance ability after stroke and positive result was found. [82].

Li et al. explored the effect of ankle strategy stability limit training on balance and gait in stroke patients with hemiplegia. The patients were given this training by using visual feedback on the static long sets of a Smart Equitest Balance Master (SEBM) machine. The results showed that ankle strategy stability limit training can enhance weight-bearing on stroke patients's affected foot as well as their balance and the symmetry of their steps [83].

The recovery of dysphagia

Dysphagia (swallowing problems) is common after stroke and can cause chest infection and malnutrition. Recently, Geeganage et al assess the effectiveness of interventions for the treatment of dysphagia (swallowing therapy), and nutritional and fluid supplementation, in patients with acute and subacute (within six months from onset) stroke [84]. In their conclusion, there remains insufficient data on the effect of swallowing therapy, feeding, and nutritional and fluid supplementation on functional outcome and death in dysphagic patients with acute or subacute stroke. Behavioural interventions and acupuncture reduced dysphagia, and pharyngeal electrical stimulation reduced pharyngeal transit time. Compared with NGT feeding, PEG reduced treatment failures and gastrointestinal bleeding, and had higher feed delivery and albumin concentration. Nutritional supplementation was associated with reduced pressure sores, and increased energy and protein intake.

There are some relatively new treatments now used in China.

Electromyographic biofeedback

There are very few studies investigated the effect of electromyographic biofeedback on the dysphagia after stroke. Bogaardt et al. evaluated the efficacy of the use of surface electromyographic feedback in the treatment of stroke patients with chronic dysphagia. Their data suggest that the use of surface electromyography as biofeedback in the treatment of chronic dysphagia after stroke could be an effective adjunct to standard therapy for swallowing disorders [85].

Yao et al. observed the effect of electromyographie biofeedback therapy (EMGBFT) on dysphagia in stroke patients [86]. Fifty-three stroke patients with dysphagia were divided randomly into an EMGBFT group and a control group. The patients of EMGBFT group were given EMGBFT electrical stimulation therapy (EST) and dysphagia training, while those in the control group were given EST and dysphagia training.

It showed that the EMGBFT group has significantly better outcome than the control group after treatment ($P<0.05$) EMGBFT combined with regular rehabilitation therapy can improve patient's motor and swallowing function.

Motor Imagery (MI)

MI has also been used in dysphagia rehabilitation. Fang et al. investigated the effect of MI on dysphagia. MI was added to conventional dysphagia training and neuromuscular stimulation. Positive results had been showed for MI therapy [87].

Catheter balloon dilatation

Cricopharyngeal dysfunction (CPD) due to neurological disorders or head and neck radiation injuries is a serious cause of dysphagia (swallowing impairment). The commonly used treatments for patients with CPD are dilatation treatments, including bougies, a wire-guided polyvinyl dilator, air-filled pneumatic dilatation, and waterfilled balloon dilatation with or without endoscopy guidance [88].

Fan et al. investigated the effects of catheter balloon dilatation therapy on treating patients with dysphagia caused by neurogenic cricopharyngeal achalasia [89]. Thirty-six patients of dysphagia caused by neurogenic cricopharyngeal achalasia were diagnosed through video fluoroscopic swallowing study (VFSS). The patients were divided into a treatment group and a control group randomly. The treatment group was treated with catheter balloon dilatation therapy and routine dysphagia rehabilitation training, while the control group was treated with routine dysphagia rehabilitation training only. After treatment, VFSS scores in both groups were significantly better than those before treatment（$P<0.01$). Compared the both groups after treatment, VFSS scores in the treatment group were significantly higher than those in the control group（$P<0.05$).

Acupuncture

Acupuncture has been become conventional therapy in treating stroke patients with dysphagia. Many studies have investigated the effect of acupuncture on the dysphagia, almost all studies showed positive results [90,91].

The recovery of incontinence after stroke

Urinary incontinence is a common consequence after stroke and a statistically significant indicator of poor outcome, including disability and admission to institutional care. An increase in resources for professional development in the assessment, treatment and management of urinary incontinence is essential to improve and maintain skills in after-stroke care [92]. The two frequent used methods in China to treat stroke patients with incontinence.

Acupuncture

Acupuncture is also been widely used in stroke patients with incontinence, many studies showed the efficacy of acupuncture on the incontinence [93,94].

Electromyographic biofeedback

This approach is used to treat patients with incontinence in recent years in China, I have not found this techniques used in other countries for incontinence. Li et al. investigate the electromyographic biofeedback on urinary incontinence after stroke. Myoelectricity of pelvic muscles were captured and measured by electrode in vagina or anus. According to the type of urinary incontinence, suitable exercise model and corresponding exercises graph were designed. After treatment, the frequency of patients' urinary incontinence was reduced [95].

Overall Effect of Acupuncture on Stroke Patients

In China and elsewhere in East Asia, acupuncture has been a primary medical intervention for stroke and stroke-related disorders over the past 1,000 years [96], and in that part of the world, it continues to be used as a standard complementary therapy after stroke. In fact, a nationwide survey of 1,095 physicians from 247 Chinese hospitals between 1993 and 1994 found that 66% of Chinese doctors routinely used acupuncture to treat stroke patients, and 63% believed it to be effective [97]. Another more recent survey in 2007 among 202 Chinese acute stroke patients showed that 63.14% would choose acupuncture as part of medical intervention [98].

In a recent review, Zhang et al. systematically overview published systematic reviews and meta-analyses in order to identify whether and when acupuncture is an effective treatment. The available evidence suggests that acupuncture may be effective for treating poststroke neurological impairment and dysfunction such as dysphagia, although these reported benefits should be verified in large, well-controlled studies. On the other hand, the available evidence does not clearly indicate that acupuncture can help prevent poststroke death or disability, or ameliorate other aspects of stroke recovery, such as poststroke motor dysfunction [99].

Zhao et al. also provided an overview of evidence from systematic reviews and meta-analysis on the effectiveness, safety, and cost of acupuncture for stroke [100]. The most reliable evidence showed that there was no clear benefit of acupuncture for stroke patients in acute, subacute, or chronic stages. There was not a single economic analysis of acupuncture for treatment of stroke.

Acupuncture treatment seems to be relatively safe. The evidence for the effectiveness of acupuncture for stroke was inconclusive, mainly due to poor methodological quality and small samples. For future research, further high-quality, randomized controlled trials with long-term follow-up are needed, as well as economic analysis.

Conclusions

In this article, I reviewed recent studies in stroke rehabilitation in China, because most articles are published in Chinese and cannot be read by foreigners. "Standardized tertiary rehabilitation" is a suitable rehabilitative care system in China. Almost all advanced techniques have been used in China, but high-quality studies are still less. Many researchers in China are engaged in motor recovery studies, active and repetitive trainings are recommended, but the optimal intensity of training is still unclear, perhaps specific for different individuals. Core muscle strengthening is a novel approach for balance training in stroke patients. For dysphagia, catheter balloon dilatation is used often in neurogenic cricopharyngeal achalasia and has got satisfied results. Acupuncture has been a primary medical intervention for stroke and stroke-related disorders over the past 1,000 years. It has been used in treating stroke patients in many residual disabilities, such as altered consciousness/attention/alertness, motor and sensory deficit, aphasia, dysphagia, incontinence, et al. But so far, the available evidence does not clearly indicate that acupuncture can help prevent poststroke death or disability, or ameliorate other aspects of stroke recovery, such as poststroke motor dysfunction.

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