Heliyon 9 (2023) e18157

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Review article

Scalp acupuncture and computer assisted cognitive rehabilitation for stroke: A meta-analysis of randomised controlled trials

Jinliang Xiao [a,b], Tian Wang [b], Bingyun Ye [b], Chunzhi Tang [a,*]

[a] Guangzhou University of Traditional Chinese Medicine Acupuncture Rehabilitation Clinical Medical College, Guangzhou, Guangdong, China
[b] The Seventh Affiliated Hospital of Southern Medical University, Foshan, Guangdong, China

ARTICLE INFO

Keywords:
Scalp acupuncture
Computer assisted cognitive rehabilitation
Cognitive impairment
Stroke patients
Meta analysis

ABSTRACT

Objective: To assess the clinical effectiveness of scalp acupuncture and computer assisted cognitive rehabilitation in the treatment of cognitive impairment in stroke patients.
Methods: The literatures published before August 2021 in the following databases were included: PubMed, Chinese Biomedical Database, Wanfang Database, China National Knowledge Infrastructure, Database of Chinese sci-tech periodicals (VIP), EBSCO Information Services, MEDLINE and Web of Science. Only randomised controlled trials (RCTs) were included. Primary outcomes were the Loewenstein Occupational Therapy Cognitive Assessment (LOTCA) and Montreal Cognitive Assessment (MoCA). Our secondary outcome was Modified Barthel Index Score (MBI). The quality of all included trials was evaluated according to the Cochrane Collaboration. This protocol was registered in PROSPERO (CRD42016048528).
Results: Sixteen articles were selected including 1333 patients. The result of the meta analysis showed that the combination of scalp acupuncture and computer assisted cognitive rehabilitation had a significant improvement in the cognitive impairments. The analysis of LOTCA showed the improvement on the LOTCA ($p < 0.0001$, $n = 410$, $I2 = 86\%$, mean difference 8.31). The meta-analysis of the MOCA showed a weighted mean difference of 3.76 and 95% confidence intervals (CI) of 2.90–4.62 ($p < 0.0001$, $n = 301$). Besides, it was showed that the combination therapy played an important role in the improvement of the score of MBI with a weighted mean difference of 9.30 and 95% confidence intervals (CI) of 5.87–12.672 ($p < 0.0001$, $n = 278$).
Conclusions: Scalp acupuncture and computer assisted cognitive rehabilitation appears to be effective for stroke patients with respect to certain outcomes. However, the evidence thus far is inconclusive. Further high-quality RCTs following standardized guidelines with a low risk of bias are needed to confirm the effectiveness of acupuncture for postpartum depression.

1. Introduction

Stroke is a prevalent disease among the elderly, which occurs when brain blood vessels unexpectedly burst or become clogged [1]. As a consequence of varying degrees of brain tissue damage, more than half of stroke survivors have cognitive impairment [2,3,4]. This impairment may manifest as aphasia, dyslexia, dementia, and memory loss, significantly impacting the patients' daily life, physical and emotional health. Additionally, cognitive impairment may reduce patients' capacity to perceive and adapt to their external

* Corresponding author.
E-mail address: jordan664@gzucm.edu.cn (C. Tang).

https://doi.org/10.1016/j.heliyon.2023.e18157
Received 3 November 2022; Received in revised form 26 May 2023; Accepted 10 July 2023
Available online 11 July 2023
2405-8440/

environment, thus decreasing their quality of life [2,3,4]. Therefore, rehabilitation therapists must develop effective treatment plans to aid in the recovery of cognitive function in stroke patients [5].

Various cognitive rehabilitation techniques are currently used, including occupational therapy, exercise training, errorless learning, cognitive neuropsychological rehabilitation, computer-assisted cognitive training, and electroacupuncture treatment [6–10]. Scalp acupuncture is a traditional Chinese medical practice that involves the insertion of fine needles into specific stimulation areas on the scalp to stimulate brain cells with neurological deficiencies caused by ischemic stroke and hypoxia stroke, thereby aiding patients in regaining stroke function [11]. In China, scalp acupuncture has been a traditional treatment method for thousands of years. In the past 13 years, a complete theoretical system, including anatomy, neurophysiology, and biological holographic theory, has formed around scalp acupuncture, highlighting its importance in aiding stroke sufferers. Multiple clinical investigations have shown acupuncture's potential as a therapeutic intervention for post-stroke cognitive impairment [12]. However, scalp acupuncture is a specialized technique that involves the insertion of needles into specific zones on the scalp that correspond to different regions of the brain, making it more effective at treating certain neurological and psychiatric conditions, such as stroke, Parkinson's disease, and depression, than acupuncture at specific points on the head.

Cognitive rehabilitation is a treatment method that aims to help patients recover their ability to process information and perform functions after brain injury, facilitating problem-solving and improving their ability to care for themselves [13]. However, with recent advances in computer technology, computer-assisted cognitive rehabilitation training (CACR) has emerged as a new cognitive rehabilitation method in clinical therapy [14]. Despite these rapid changes, the late introduction of computer-assisted training in China has meant that most occupational therapists continue to rely on manual training. In recent years, research has focused on investigating the role of CACR, and some researchers have explored the combination of CACR and acupuncture to promote cognitive function restoration through central nerve stimulation and external cognitive stimulation. One study published in the Journal of Acupuncture and Meridian Studies in 2018 investigated the effectiveness of combining scalp acupuncture with computer-assisted cognitive rehabilitation training for the treatment of mild cognitive impairment (MCI) [15]. The study involved 60 patients with MCI who were randomly assigned to three groups: a scalp acupuncture group, a computer-assisted cognitive rehabilitation training group, and a combined treatment group. The results of the study showed that all three groups demonstrated significant improvements in cognitive function after the treatment. However, the combined treatment group showed greater improvements in global cognitive function, attention, memory, and executive function than the other two groups. The authors of the study suggested that the combined treatment approach may be more effective than using either treatment modality alone because scalp acupuncture can enhance the neural plasticity and improve blood flow to the brain, while computer-assisted cognitive rehabilitation training can provide targeted cognitive training to improve specific cognitive domains.

The present study explores the potential benefits of combining scalp acupuncture with computer-assisted cognitive rehabilitation training (CACR) for the treatment of cognitive impairment in stroke patients. The efficacy of such a combined therapy was examined by investigating the association between traditional Chinese treatment and the development of CACR. Specifically, the aim of this study was to determine whether the combination of scalp acupuncture and CACR improves the cognitive function and quality of life of stroke patients. The study was guided by the PICO (population, intervention, comparison, and outcome) question: "Does the combination of scalp acupuncture and CACR assist stroke patients in improving their cognitive function and quality of life?"

2. Materials and methods

2.1. Inclusion criteria and exclusion criteria

The inclusion criteria were the following: (1) type of studies: randomised controlled trials (RCTs) were included; (2) type of participants: patients with a definite clinical diagnosis of stroke and residual cognitive impairment and over 18 years old were included, and both hemorrhagic and ischemic stroke patients were included; (3) type of interventions: the treatment group was scalp acupuncture combined with computer-assisted cognitive training, and the control group was the regular cognitive treatment. If the 2 groups also used other identical interventions (e.g., regular electroacupuncture, etc.), they could also be included; (4) outcome measurements: the outcome was assessed by MMSE, MoCA and MBI; (5) types of comparators: sham acupuncture or conventional cognitive treatment with rehabilitation could be used as comparison therapies. If a study contained three or more groups, with just one group receiving scalp acupuncture combined with computer-assisted cognitive training and a control group not receiving acupuncture and any cognitive training who were treated in the same way as the acupuncture group, the data from the treatment group and the control group were chosen for this study.

2.2. Information sources and search strategy

The searching of literature was performed by 2 investigators (X.J.L. and W.T.). The literatures published before August 2021 in the following databases were included: PubMed, Chinese Biomedical Database, Wanfang Database, China National Knowledge Infrastructure, Database of Chinese sci-tech periodicals (VIP), EBSCO Information Services, MEDLINE and Web of Science. Taking pubmed as example, we used the combining text terms and, where appropriate, MeSH terms for scalp acupuncture ("scalp acupuncture" or "head acupuncture" or "cranial acupuncture" or "cephalic acupuncture" or "scalp electric acupuncture" or "scalp penetration acupuncture") and computer-assisted cognitive training and stroke ("cerebrovascular disorders" or "cerebrovascular disease" or "stroke" or "brain infarction" or "apoplexy") and "cognitive impairment" ("cognitive impairment" or "cognitive dysfunction" or "cognitive problems"). No limits were applied for language and country.

2.3. Study selection and data collection process

In an unblinded standardized method, two investigators (X.J.L. and W.T.) examined the titles and abstracts to choose potential references. All potentially relevant studies' full articles were retrieved. The two investigators then independently read the selected papers and made a final selection judgment. Disagreements with other authors were resolved through conversation or consultation (T.C.Z. and Y.B.Y.).

2.4. Assessment of risk of bias

Using the risk of bias tool from the Cochrane Handbook for Systematic Reviews of Interventions, two reviewers (X.J.L. and W.T.) independently assessed the methodological quality and risk of bias of the included studies (version 5.3). This instrument consisted of seven distinct domains: random sequence generation, allocation concealment, blinding of participants and employees, blinding of outcome assessment, incomplete outcome data, selective reporting, and additional bias. A third researcher (T.C.Z.) was responsible for verification and revisions where there were variances in the quality rating method.

2.5. Data analysis and synthesis

Statistical heterogeneity tests and combined data analyses were performed using the Cochrane RevMan software (version 5.4, 020). The count data were presented as odds ratio (OR) and the measurement data were presented as the mean difference (MD). Studies with $p \geq 0.1$ and $I2 \leq 50\%$ were considered homogeneous and were analyzed using a fixed effect model. When $p < 0.1$ or $I2 > 50\%$, the studies were considered heterogeneous, a random-effect model was adopted, and the research results were carefully interpreted. The 95% confidence interval (CI) was calculated and the difference was considered statistically significant when $p < 0.05$.

Omitting a single study in turn and repeating meta-analysis through a fixed-effects model were employed to perform sensitivity analyses. Sensitivity analyses and publication bias were conducted only on LOTCA, MOCA, and MBI because of quantity limitations of included studies.

3. Result

3.1. Search outcomes

We found a total of 149 articles after searching several databases using the keywords. Following the removal of duplicate entries, 117 articles remained. After first screening, another 92 items were eliminated from the remaining group. 8 articles were removed because the full text was unavailable, 4 articles were removed because the researchers used acupuncture in locations other than the head, 1 article was removed because computer-assisted treatment was not used, 3 articles were removed because specific data were

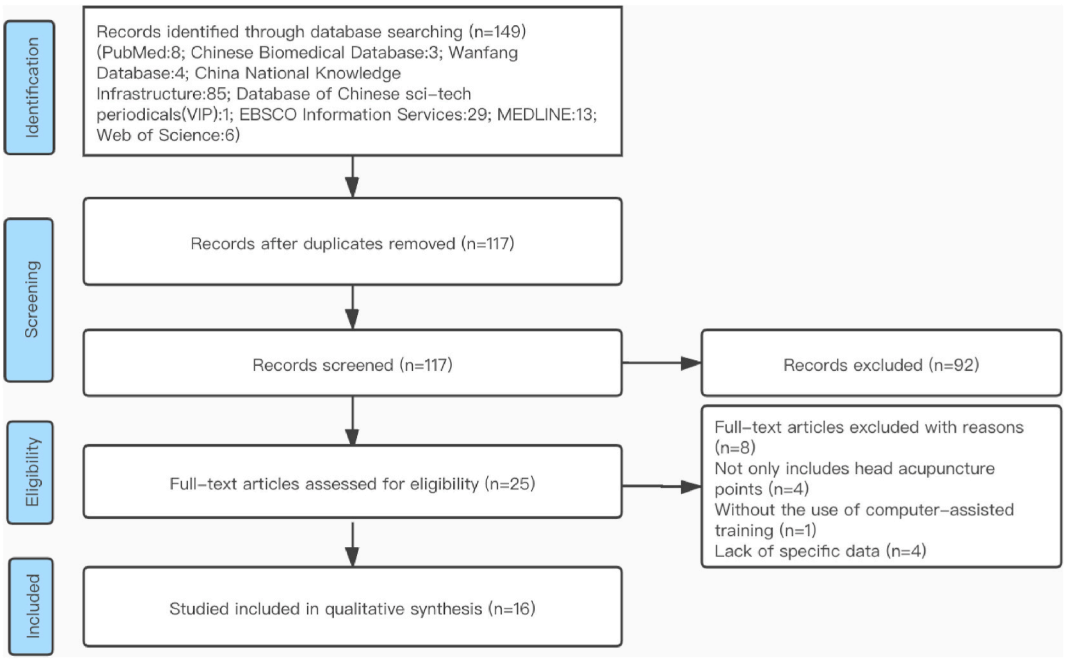


Fig. 1. Flow diagram for literature search.

Table 1

Summary of the included studies and the detail of intervention and measurement, LOTCA = The Loewenstein Occupational Therapy Cognition Assessment, FMA = The Fugl-Meyer assessment, It-NIHSS = the National Institutes of Health Stroke Scale, FIM = the Functional Independence Measure, MMSE = Mini–mental state examination, MoCA = Montreal Cognitive Assessment, MBI = Modified Barthel Index, TMT = Trail Making Test, T2B = Test des Deux Barrages,EQ-5D = EuroQol Questionna.

Author	Participants	Intervention (follow up)	Control/comparison	Outcome measures	Results
Du et al., 2018 [16]	N = 60 Age range: 18–70	Scalp acupuncture for 12 weeks, kept for 30 min, once per day and 5 days per week. (n = 30)	Conventional treatment, once per 40 min, once per day, and 5 days per week), including routine medical treatments and rehabilitation treatment (n = 30)	Measured at baseline and at the end of treatment Cognitive function assessment: LOTCA	Cognitive function assessment: LOTCA scores for 2 groups after treatment all significantly increase and the improvement were more obvious compared with those before treatment ($P < 0.05$). The scores of LOTCA subitems in both groups were higher than those before treatment, and the difference was statistically significant ($P < 0.05$). In the 3 aspects of orientation, visual motor organization and thinking operation, the treatment group scores were higher than the control group, and the difference was statistically significant ($P < 0.05$). In terms of perception and attention, there was no statistical difference between the 2 groups ($P > 0.05$).
Huang et al., 2015 [17]	N = 60 Age range: 18–80	Computer-assisted cognitive training and acupuncture (n = 20), once per 30 min, once per day, and 5 days per week for 4 weeks	Computer-assisted cognitive training (n = 20), once per 30 min, once per day, and 5 days per week for 4 weeks	Measured at baseline and at the end of treatment neuropsychological: The Test for Attentional Performance (TAP)、Trail Making Test (TMT)、Test des Deux Barrages (T2B)、National Institute of Health Stroke Scale (NIH-SS) daily activities: MBI health outcome: EuroQol Questionnaire (EQ-5D)	
Hyeng Kyu Park et al., 2016 [18]	N = 45 Age range: 20–90	Electro acupuncture therapy and computerized cognitive rehabilitation during the period of CCRT (n = 15) once per day, and 3 days per week for 8 weeks)	Computerized cognitive rehabilitation treatment (CCRT) (n = 15) (once per day, and 3days per week for 8 weeks)	Measured before intervention, at the end of intervention, 8 weeks after the first intervention, and 4 weeks after completion of the intervention Cognitive function assessment: LOTCA Daily activities: MBI Quality of Life: EQ-5D-3L	
Xiong et al., 2020 [19]	N = 70 Age range: 30–80	Scalp acupuncture and cognitive training (n = 35) 3~4 h per day, six days per week for 8 weeks	Sham scalp acupuncture and cognitive training (n = 35) 2 per day for 12 weeks	Measured before and after treatment Cognitive function: MMSE, LOTCA Daily activities: MBI Motor function: FMA	Cognitive function: MMSE: Significant improvements were found in both the experimental group and control group following the 12-week treatment ($p < 0.05$). However, there was no significant difference between the experimental and control groups following treatment ($p > 0.05$). LOTCA: the total LOTCA scores were significantly higher in the experimental group than in the control group post-treatment ($p < 0.05$) Daily activities: the ADL scores in the experimental group were significantly

(continued on next page)

Table 1 (*continued*)

Author	Participants	Intervention (follow up)	Control/comparison	Outcome measures	Results
					lower than those in the control group ($p < 0.05$) Motor function: the FMA scores in the experimental group were significantly higher than those in the control group ($p < 0.05$)
Yang et al., 2014 [20]	N = 240 Age range: 18–75	the combination of acupuncture and RehaCom cognitive training (n = 60) 30 min per day, and 5 days per week for 12 weeks	Conventional treatment (n = 60) 30 min per day, and 5days per week for 12 weeks	Measured at baseline and again at 4, 8 and 12 weeks (within a time window: ±3 days) Neuropsychological: MMSE, MoCA, FIM	
Wang et al., 2016 [21]	N = 60 Age range: ?	Scalp acupuncture and Computer-assisted cognitive training (n = 20) 30 min per day, and 6 days per week for 8 weeks	Computer-assisted cognitive training (n = 20) 30 min per day, and 6 days per week for 8 weeks	Measured at baseline and after treatment Cognitive function: LOTCA Motor function: FMA Daily activities: MBI	LOTCA: significantly improved of cognitive function score in the intervention group compared with control group (P < 0.01). In the aspects of visual motor organization and thinking operation, the treatment group scores were higher than the control group, and the difference was statistically significant (P < 0.01). FMA: significantly improved of motor function score in the intervention group compared with control group (P < 0.01) MBI: significantly improved of daily activities score in the intervention group compared with control group (P < 0.01)
Zhang2 et al., 2020 [22]	N = 120 Age range: 39-71	Scalp acupuncture and Computer-assisted cognitive training (n = 60) Once per day, and 5 days per week for 8 weeks	Scalp acupuncture (n = 60) Once per day, and 5 days per week for 8 weeks	Measured at baseline and after treatment Cognitive function: MMSE, HDS and WAIS Daily activities: BI Quality of Life: SIS	Cognitive function: significantly improved of MMSE, HDS and WAIS score in the intervention group compared with control group (P < 0.05). Daily activities: significantly improved of SIS score in the intervention group compared with control group (P < 0.05).
Xing et al., 2017 [23]	N = 86 Age range: 52-79	Scalp acupuncture and Computer-assisted cognitive training (n = 30) Once per day, and 6 days per week for 8 weeks	Computer-assisted cognitive training (n = 26) 30 min per day, and 6 days per week for 8 weeks	Measured at baseline and after treatment Cognitive function: LOTCA Motor function: FMA Daily activities: MBI Quality of Life: EQ-5D-3L	Cognitive function: In the aspects of orientation, thinking operation and motor praxis, the treatment group scores were higher than the control group, and the difference was statistically significant (P < 0.005). FMA: significantly improved of motor function score in the intervention group compared with control group (P < 0.05) MBI: significantly improved of daily activities score in the intervention group compared with control group (P < 0.05)
Wang et al., 2011 [24]	N = 60 Age range: 35–75	Scalp acupuncture and Computer-assisted cognitive training (n = 20) 6 days per week for 4 weeks	Computer-assisted cognitive training (n = 20)	Measured at baseline and after treatment Cognitive function: MMSE	Cognitive function: significantly improved of MMSE score in the intervention group compared with control group (P < 0.01).

(*continued on next page*)

Table 1 (*continued*)

Author	Participants	Intervention (follow up)	Control/comparison	Outcome measures	Results
Wang et al., 2018 [25]	N = 120 Age range: 35–70	Scalp acupuncture and Computer-assisted cognitive training (n = 40) 6 days per week for 4 weeks	Computer-assisted cognitive training (n = 40) 6 days per week for 4 weeks	Measured at baseline and after treatment Cognitive function: MMSE	Cognitive function: significantly improved of MMSE score in the intervention group compared with control group (P < 0.01).
Lin et al., 2015 [26]	N = 40 Age range: 38–75	Scalp acupuncture and Computer-assisted cognitive training (n = 20) 30 min per day, 6 days per week for 4 weeks	Scalp acupuncture and manual cognitive training (n = 20) 30 min per day, 6 days per week for 4 weeks	Measured at baseline and after treatment Cognitive function: MOCA	Cognitive function: significantly improved of MMSE score in the intervention group compared with control group (P < 0.05).
Han et al., 2014 [27]	N = 185 Age range: ?	Scalp acupuncture and Computer-assisted cognitive training (n = 62) 30 min once time, 2 times per day, 5 days per week for 6 weeks	Computer-assisted cognitive training (n = 62) 30min once time, 2 times per day, 5 days per week for 6 weeks	Measured at baseline and after treatment Cognitive function: LOCTA	Cognitive function: significantly improved of LOTCA score in the intervention group compared with control group (P < 0.05)
Zhang et al., 2020 [28]	N = 60 Age range: 60–80	Scalp acupuncture and Computer-assisted cognitive training (n = 30) 30 min per day, 5 days per week for 6 weeks	Computer-assisted cognitive training (n = 30) 30 min per day, 5 days per week for 6 weeks	Measured at baseline and after treatment Cognitive function: MOCA	Cognitive function: significantly improved of MOCA score both in the intervention group and control group compared with the baseline (P < 0.05). Except of the area of abstract ability, the scores of other areas was significantly improved in intervention group compared with control group (P < 0.05).
Hua et al., 2016 [29]	N = 100 Age range: 48–74	Scalp acupuncture and Computer-assisted cognitive training (n = 50) Once one day, 10 times totally	Scalp acupuncture and manual cognitive training (n = 50)	Measured at baseline and after treatment Cognitive function: MMSE	Cognitive function: significantly improved of MMSE score in the intervention group compared with control group (P < 0.05)
Yu et al., 2013 [30]	N = 90 Age range: 25–77	Scalp acupuncture and Computer-assisted cognitive training (n = 30) 30 min per day, 6 days per week for 2 months	Computer-assisted cognitive training (n = 30) 30 min per day, 6 days per week for 8 weeks	Measured at baseline and after treatment Cognitive function: LOTCA Memory: MCY-08-03	Cognitive function: significantly improved of LOTCA scores and other memory assessments in the intervention group compared with control group (P < 0.05)
Chen et al., 2020 [31]	N = 60 Age range:?	Scalp acupuncture and Computer-assisted cognitive training (n = 30) 30 min per day, 6 days per week for 8 weeks	Computer-assisted cognitive training (n = 30) 30 min per day, 6 days per week for 4 weeks	Measured at baseline and after treatment Cognitive function: MOCA Daily activities: MBI	Cognitive function: significantly improved of MOCA score in the intervention group compared with control group (P < 0.05) Daily activities: significantly improved of MBI score in the intervention group compared with control group (P < 0.05)
Li et al., 2019 [32]	N = 62 Age range: 38–77	Scalp acupuncture and Computer-assisted cognitive training (n = 31) 30 min one time, 2 times one day, 5 days per week for 2 months	Computer-assisted cognitive training (n = 31) 30 min one time, 2 times one day, 5 days per week for 2 months	Measured at baseline and after treatment Cognitive function: MOCA Daily activities: MBI	Cognitive function: significantly improved of MOCA score in the intervention group compared with control group (t = 2.9, P < 0.05) Daily activities: significantly improved of MBI score in the intervention group compared with control group (t = 2.69, P < 0.05)
Wei et al., 2019 [33]	N = 60 Age range: 45–75	Scalp acupuncture and Computer-assisted cognitive training (n = 30) 30 min one day, 5 days per week for 6 months	Computer-assisted cognitive training (n = 30) 30 min one day, 5 days per week for 6 months	Measured at baseline and after treatment Cognitive function: MOCA Neuro function: NHISS	Cognitive function: significantly improved of MMSE score in the intervention group compared with control group (P < 0.05) Neuro function: significantly improved of NHISS score in the intervention group

(*continued on next page*)

Table 1 (*continued*)

Author	Participants	Intervention (follow up)	Control/comparison	Outcome measures	Results
					compared with control group (P < 0.001)
Guan et al., 2019 [34]	N = 88 Age range: 18–80	Scalp acupuncture and Computer-assisted cognitive training (n = 29) 30 min one day, 6 days per week for one month	Computer-assisted cognitive training (n = 30) 30 min one day, 6 days per week for one month	Measured at baseline and after treatment Cognitive function: MOCA	Cognitive function: significantly improved of MOCA score in the intervention group compared with control group (P < 0.05)

missing, and 1 article was removed because the data were from the same experiment. A flowchart depicts the screening procedure's outline (Fig. 1).

3.2. Characteristics of included studies

All sixteen investigations were conducted by Chinese researchers; fourteen were published in Chinese publications and two in foreign journals. Each study was conducted at a solitary location. 793 men and 450 women participated in the 16 investigations, totaling 1333 participants. Their mean age was 57.55, and the standard deviation was 9.05 years. Their average sickness duration was 49.4 days, with a standard deviation of 14.94 days. Three of the publications did not specify the duration of the patients' illnesses (31, 35). In the included literature, nine articles had a head acupuncture approach based on the Chinese Acupuncture Society's International Standardized Scheme of Scalp Acupuncture Point Names, with specific selection of acupuncture points for the anterior and posterior parietotemporal oblique lines and bilateral treatment. There are, however, additional articles that discuss particular acupuncture sites. For instance, Zhang discusses their employment of the five head acupoints Sishencong, Shenting, Benshin, Baihui, and Fengchi. The precise features of the included studies are listed in Table 1 below.

Fig. 2. The included trials scored according to the risk of bias criteria.

3.3. Risk of biases of included studies

The items random sequence generation and allocation concealment were assessed as low risk of bias in most of the included studies expect of the Yu 2013. for the items of blinding participants and personnel and blinding of outcomes assessment and other bias was assessed unclearly in most of included articles because of no mentions. However, for the selective repotting, all of the articles were scored low risk of bias. The methodological quality of each study is described in Fig. 2.

3.4. Meta-analysis results

The pooled meta-analysis of the data showed a weighted mean difference of 8.31 and 95% confidence intervals (CI) of 5.31–11.30 on the LOTCA ($p < 0.0001$, $n = 410$). We performed sensitivity analysis when pooling data from these 4 trials, which failed to change the statistical significance on LOTCA. When omitting a study in turn, pooled values ranged from MD: 8.31; 95% CI (5,31, 11.30) to MD: 9.11; 95% CI (5,41, 12.81) for LOTCA (Fig. 3 A and B).

The pooled meta-analysis of the data showed a weighted mean difference of 3.76 and 95% confidence intervals (CI) of 2.90–4.62 on the MOCA ($p < 0.0001$, $n = 301$). Summary effect size did not change in sensitivity analysis, and effect sizes ranged from MD: 3.76; 95% CI (2.90, 4.62) to MD:3.91; 95% CI (2.94, 4.88) for MOCA (Fig. 4 A and B).

The pooled meta-analysis of the data showed a weighted mean difference of 9.30 and 95% confidence intervals (CI) of 5.87–12.72 on the MBI ($p < 0.0001$, $n = 278$). Summary effect size did not change in sensitivity analysis, and effect sizes ranged from MD: 9.30; 95% CI (5.87, 12.72) to MD:10.95; 95% CI (7.77, 14.13) for MBI (Fig. 5A and B).

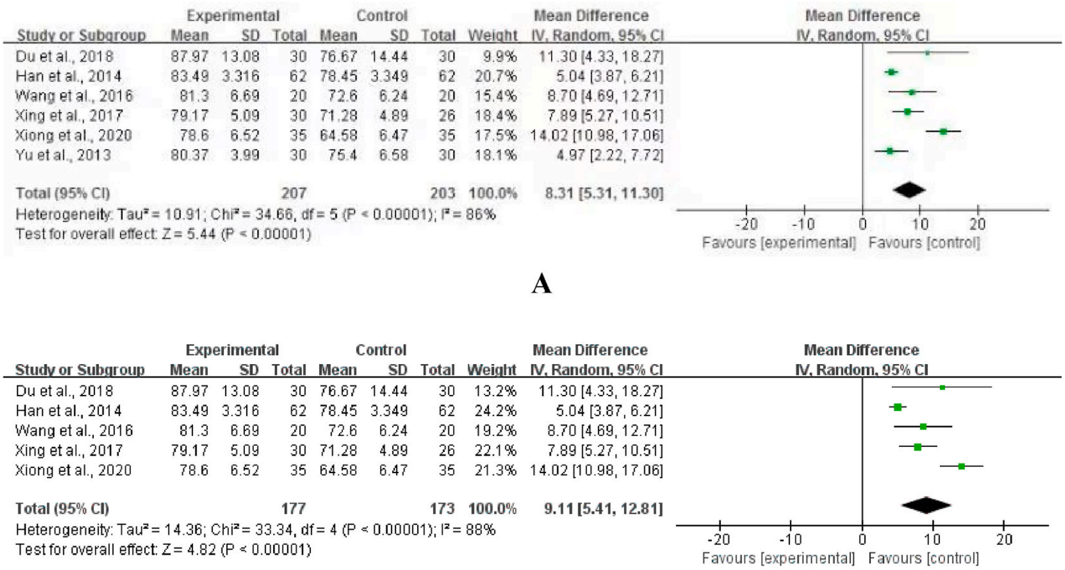
For the meta analysis of MMSE, we have divided it into two parts for comparison. The first comparison was to define the experimental group as a combination of scalp acupuncture and CACR, while the control group was defined as the scalp acupuncture group. The weighted mean difference was 9.30 and 95% confidence intervals (CI) was 5.87–12.72 on the MBI ($p < 0.0001$, $n = 278$). The second comparison still defined the experimental group as the combined group of scalp acupuncture and CACR, but the control group as the CACR group. At this time, The weighted mean difference was 2.25 and 95% confidence intervals (CI) was 0.44–4.906 on the MBI ($p < 0.0001$, $n = 190$) (Figs. 6 and 7).

The results indicated that acupuncture had a significant effect on PSCI, and no adverse events were reported in those studies.

4. Discussion

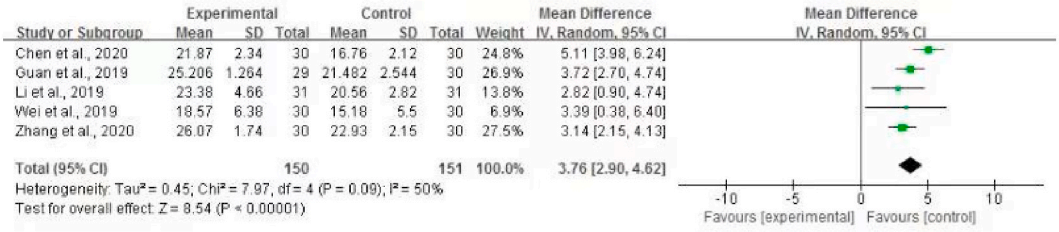
The present study aimed to investigate the efficacy of combining scalp acupuncture with computer-assisted cognitive rehabilitation (CACR) in the treatment of cognitive impairments. The study involved a meta-analysis of sixteen randomised controlled trials (RCTs) with a total of 1333 participants.

The results of the meta-analysis showed a significant improvement in cognitive deficits in the intervention groups compared to the control groups, as measured by the Loewenstein Occupational Therapy Cognitive Assessment (LOTCA) and the Montreal Cognitive Assessment (MOCA). Specifically, six studies with a total of 510 individuals demonstrated an improvement in LOTCA scores, while five

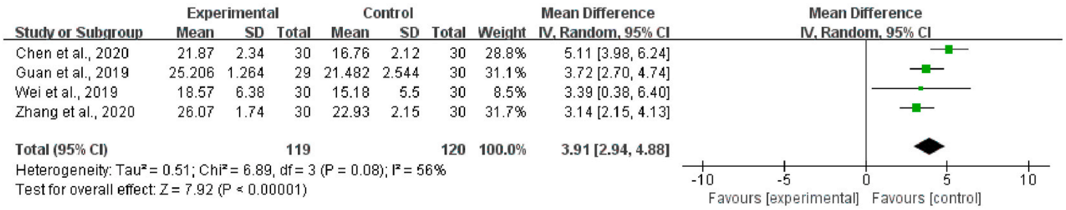


B

Fig. 3. A. Forest plot comparing the LOTCA improved between combination groups and control groups. **B.** Forest plot comparing the LOTCA in sensitivity analysis.

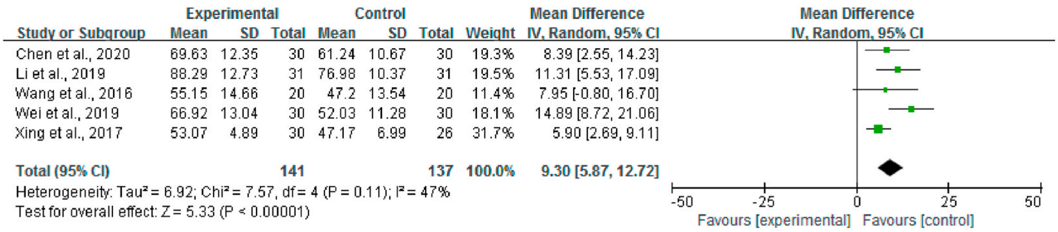


A

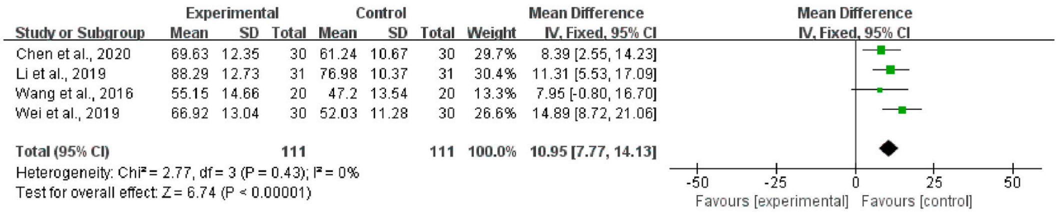


B

Fig. 4. A. Forest plot comparing the MOCA improved between combination groups and control groups. B. Forest plot comparing the MOCA in sensitivity analysis.



A



B

Fig. 5. A. Forest plot comparing the MBI improved between combination groups and control groups. B. Forest plot comparing the MBI in sensitivity analysis.

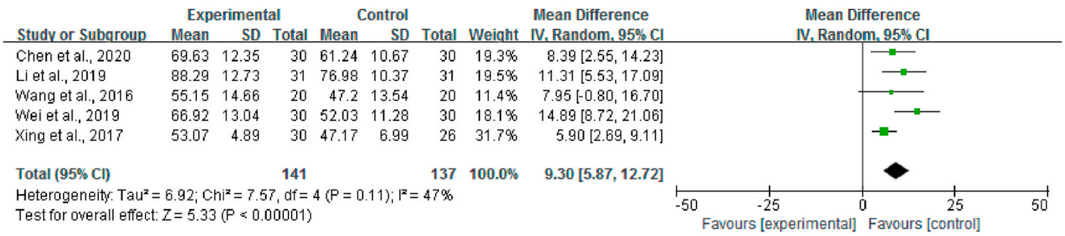


Fig. 6. Forest plot comparing the MMSE improved between combination groups and scalp acupuncture groups.

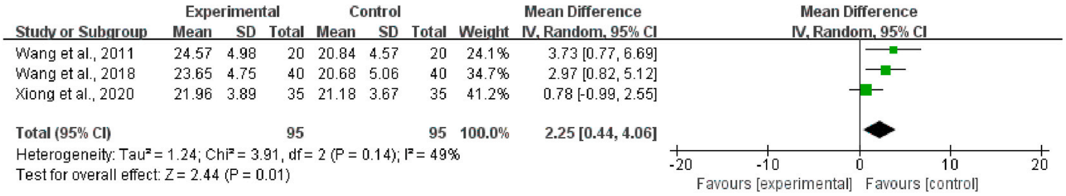


Fig. 7. Forest plot comparing the MMSE improved between combination groups and CACR groups.

studies showed that the intervention groups outperformed the control groups in terms of MOCA scores. One of the included studies compared manual cognitive training to computerized cognitive training under scalp-needle stimulation and found that computerized cognitive training may be more effective in promoting patient recovery. Another investigation evaluated the effect of retention time variations of scalp needles with the same cognitive stimulation on patient recovery. The optimal acupuncture points for scalp acupuncture were identified as Sishencong, Shenting, Benshin, Baihui, and Fengchi, with a recommended treatment frequency of 30 min per day, 6 days per week, for a duration of 4–8 weeks. The results suggested that a longer retention time of scalp needles maintained longer-lasting stimulation and increased brain blood flow more efficiently.

According to the meridian theory in Chinese medicine, the human head is considered the control center for many organs. In particular, cognitive functions are associated with specific areas of the brain, including the parieto-temporal anterior oblique line and the parieto-temporal posterior oblique lines, which are located in the parietal, frontal, and temporal lobes [35]. Scalp acupuncture at these locations can stimulate cortical projections to the scalp, increase cerebral blood flow to the affected area, enhance functional brain activity, and modify the levels of various biomolecules, such as vascular endothelial growth factor, plasma endothelin, and calcitonin gene-related peptide [36]. These effects may assist in opening collateral circulation in the ischemic area, managing vasodilation and contraction, and improving the ischemic and hypoxic condition of brain tissue surrounding the lesion, thereby facilitating a seamless memory loop [37,38].

The computerized cognitive evaluation and training system has been increasingly implemented in clinical practice since its inception. In China, several studies have confirmed the efficacy of CACR for the treatment of cognitive disorders [39,40]. Compared to traditional manual cognitive training, computer-assisted training provides a rich array of stimulation, including visual, auditory, and dynamic stimuli, and is easy to operate, resulting in greater patient compliance and interest.

The present study highlights the potential benefits of combining acupuncture with cognitive training in stroke patients. By utilizing a multimodal treatment approach, the subjective initiative of patients can be fully utilized, thereby maximizing the mobilization of potential factors and engaging the entire brain. As the cognitive function of the human body is exceedingly complex, pure cognitive function training that employs recurrent audiovisual stimulation may not be sufficient to pharmacologically activate brain cells. Therefore, the addition of direct somatic stimulation, such as acupuncture, can enhance neural responses and functional reconfiguration. The combination of acupuncture and cognitive training can compensate for a lack of specific functional stimulation and exercise, such as audio-visual, reading, and writing. As a result, this multimodal approach may offer a more comprehensive and effective treatment strategy for cognitive impairments. Further research is needed to fully elucidate the underlying mechanisms and optimize the application of this treatment approach in clinical practice.

The findings of this study suggest that the combination of scalp acupuncture and computer-assisted cognitive training may offer a more effective approach for improving cognitive function in stroke patients compared to computer-assisted cognitive training alone. Specifically, the addition of scalp acupuncture resulted in greater improvements in thinking and manipulation, orientation, spatial perception, and motor use. These findings have significant clinical implications and underscore the potential of this multimodal approach for the treatment of cognitive impairments in stroke patients.

Further studies are needed to replicate these findings and elucidate the underlying mechanisms by which scalp acupuncture and computer-assisted cognitive training may interact to promote cognitive function. Additionally, future research may seek to optimize the application of this treatment approach by identifying patient subgroups that may benefit most from this intervention, as well as exploring potential modifications to treatment parameters, such as frequency and duration of treatment sessions. Ultimately, the findings of this study have important implications for the clinical management of stroke patients and highlight the potential of integrating traditional Chinese medicine with modern technology in the treatment of cognitive impairments.

5. Limitation

There remain limitations in our analysis. First, in the included publications, the placements of acupuncture needle stimulation on the scalp were not necessarily the same for each patient. It may cause patients to experience varied amounts of excitement, undermining the credibility of the articles. Second, not all institutions employ identical digital cognitive equipment. Despite the fact that the majority of cognitive training systems appear to be in a game mode, the training patterns and signals are not similar, resulting in diversity. Thirdly, all of the included papers appear to have better effects, which does not rule out the possibility that the researchers caused artificial blindness to acquire results. Fourth, all sixteen included studies were conducted by Chinese researchers and appear to have good effects, which may increase the selection bias and report bias.

6. Conclusion

According to the research so far, combining scalp acupuncture with CACR is a successful treatment for improving cognitive function in stroke patients. However, the majority of the data gathered thus far has come from an overvalued literature, and the material's legitimacy cannot be validated. In addition, the included literature did not cover adverse effects. To confirm the therapy's efficacy, more literature is needed to describe the details of treatment and adverse time.

Author contribution statement

All authors listed have significantly contributed to the development and the writing of this article.

Funding statement

TFEB/TFE3-mediated autophagy-based study of the molecular mechanism of "Zhisanjiu" inhibition of neuroinflammation in Alzheimer's disease. Molecular mechanism of neuroinflammation in Alzheimer's disease (Grant No.: 82174479).

Data availability statement

Data included in article/supp. material/referenced in article.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Y. Liu, M. Li, H. Zhang, H. Wang, J. Li, J. Jia, L. Zhang, A tensor-based scheme for stroke patients' motor imagery EEG analysis in BCI-FES rehabilitation training, J. Neurosci. Methods 222 (2014) 238–249.
[2] M. Sarter, C. Lustig, S.F. Taylor, Cholinergic contributions to the cognitive symptoms of schizophrenia and the viability of cholinergic treatments, Neuropharmacology 62 (3) (2012) 1544–1553.
[3] S. Yang, H. Ye, J. Huang, J. Tao, C. Jiang, Z. Lin, L. Chen, The synergistic effect of acupuncture and computer-based cognitive training on post-stroke cognitive dysfunction: a study protocol for a randomized controlled trial of 2× 2 factorial design, BMC Compl. Alternative Med. 14 (1) (2014) 1–11.
[4] J. Woo, K.O. Shin, S.Y. Park, K.S. Jang, S. Kang, Effects of exercise and diet change on cognition function and synaptic plasticity in high fat diet induced obese rats, Lipids Health Dis. 12 (1) (2013) 1–10.
[5] M.O. Park, S.H. Lee, Relationship between basic neurological cognition and social cognition among allen cognitive disability levels of acquired brain injury, Healthcare 8 (No. 4) (2020) 412. Multidisciplinary Digital Publishing Institute.
[6] C. Yoo, M.H. Yong, J. Chung, Y. Yang, Effect of computerized cognitive rehabilitation program on cognitive function and activities of living in stroke patients, J. Phys. Ther. Sci. 27 (8) (2015) 2487–2489.
[7] N.T. Hill, L. Mowszowski, S.L. Naismith, V.L. Chadwick, M. Valenzuela, A. Lampit, Computerized cognitive training in older adults with mild cognitive impairment or dementia: a systematic review and meta-analysis, Am. J. Psychiatr. 174 (4) (2017) 329–340.
[8] N. Gates, M.A.F. Singh, P.S. Sachdev, M. Valenzuela, The effect of exercise training on cognitive function in older adults with mild cognitive impairment: a meta-analysis of randomized controlled trials, Am. J. Geriatr. Psychiatr. 21 (11) (2013) 1086–1097.
[9] P. Nie, F. Liu, S. Lin, J. Guo, X. Chen, S. Chen, R. Lin, The effects of computer-assisted cognitive rehabilitation on cognitive impairment after stroke: a systematic review and meta-analysis, J. Clin. Nurs. 31 (9–10) (2022) 1136–1148.
[10] X. Kuang, W. Fan, J. Hu, L. Wu, W. Yi, L. Lu, N. Xu, Acupuncture for post-stroke cognitive impairment: a systematic review and meta-analysis, Acupunct. Med. 39 (6) (2021) 577–588.
[11] Y. Wang, J. Shen, X.M. Wang, D.L. Fu, C.Y. Chen, L.Y. Lu, G.Q. Zheng, Scalp acupuncture for acute ischemic stroke: a meta-analysis of randomized controlled trials, Evid. base Compl. Alternative Med. 2012 (2012).
[12] J.W. Zhou, L.I. Jing, J.J. Zhao, H.J. Xie, W.A.N.G. Min, Meta analysis on ischemic stroke treated with scalp acupuncture, World J. Acupuncture-Moxibustion 23 (2) (2013) 41–47.
[13] K.D. Cicerone, Y. Goldin, K. Ganci, A. Rosenbaum, J.V. Wethe, D.M. Langenbahn, J.P. Harley, Evidence-based cognitive rehabilitation: systematic review of the literature from 2009 through 2014, Arch. Phys. Med. Rehabil. 100 (8) (2019) 1515–1533.
[14] H.Y. Cho, K.T. Kim, J.H. Jung, Effects of computer assisted cognitive rehabilitation on brain wave, memory and attention of stroke patients: a randomized control trial, J. Phys. Ther. Sci. 27 (4) (2015) 1029–1032.
[15] J. Li, Y. Liang, H. Yu, Y. Liu, Effects of combined scalp acupuncture and computer-assisted cognitive rehabilitation for cognitive impairment: a randomized controlled clinical trial, J. Acupunct. Meridian Stud. 11 (6) (2018) 367–372.
[16] J. Du, J. Yin, L. Liu, J. Chen, M. He, Clinical observation of 60 cases of treating cognitive disorder after cerebral injury in combination with scalp acupuncture and cognitive training, Medicine 97 (40) (2018).
[17] J. Huang, M.A. McCaskey, S. Yang, H. Ye, J. Tao, C. Jiang, L. Chen, Effects of acupuncture and computer-assisted cognitive training for post-stroke attention deficits: study protocol for a randomized controlled trial, Trials 16 (1) (2015) 1–10.
[18] H.K. Park, M.K. Song, J.H. Kim, J.Y. Han, A randomized controlled trial to evaluate the effectiveness and safety of electro acupuncture and transcranial direct current stimulation with computerized cognitive rehabilitation in patients with vascular cognitive impairment, Medicine 99 (29) (2020).
[19] J. Xiong, Z. Zhang, Y. Ma, Z. Li, F. Zhou, N. Qiao, W. Liao, The effect of combined scalp acupuncture and cognitive training in patients with stroke on cognitive and motor functions, NeuroRehabilitation 46 (1) (2020) 75–82.
[20] S. Yang, H. Ye, J. Huang, J. Tao, C. Jiang, Z. Lin, L. Chen, The synergistic effect of acupuncture and computer-based cognitive training on post-stroke cognitive dysfunction: a study protocol for a randomized controlled trial of 2× 2 factorial design, BMC Compl. Alternative Med. 14 (1) (2014) 1–11.
[21] Jian Wang, Effect of scalp acupuncture under background music combined with computer-assisted cognitive training on cognitive impairment after stroke (in Chinese), China Rehab. (2) (2016) 128–130. CNKI:SUN:ZLKF.0.2016-02-018.
[22] Wei Zhang, zhou, Jian Jia, The clinical effect of computer-assisted cognitive rehabilitation training combined with acupuncture in the treatment of cognitive dysfunction after stroke (in Chinese), Clin. Med. Res. Pract. (35) (2020) 163–165, https://doi.org/10.19347/j.cnki.2096-1413.202035059.

[23] Wei Xing, Linna Huang, Ruoping Zhang, Efficacy of long-term retention of scalp needles on cognitive impairment in patients with stroke (in Chinese), Southwest Nat. Def. Med. 10 (2017) 1120–1122. CNKI:SUN:XNGF.0.2017-10-034.
[24] Yan Wang, Li Zhang, Shurong Li, Zhenyu Li, Qiang Tang, The effect of scalp acupuncture combined with cognitive training on cognitive dysfunction in patients with cerebral infarction (in Chinese), Chin. Rehab. Theory Pract. (4) (2011) 316–318. CNKI:SUN:ZKLS.0.2011-04-009.
[25] Yongxin Wang, Miao Wei, Hongshun Zhang, Lichun Wang, Ji Liu, Xiangyang Ma, Xiaohua Wu, The effect of scalp cluster acupuncture combined with cognitive rehabilitation on cognitive impairment after cerebral infarction (in Chinese), Herald Chin. Med. (17) (2018) 84–86+93, https://doi.org/10.13862/j.cnki.cn43-1446/r.2018.17.025.
[26] Lin Qian, Meiyun Chen, Xiuyao Lin, Observation on the efficacy of scalp acupuncture combined with computer-assisted cognitive training in the treatment of cognitive dysfunction after stroke (in Chinese), J. Pract. Trad. Chin. Med. (11) (2015) 1039–1040. CNKI:SUN :ZYAO.0.2015-11-046.
[27] Bing Han, Jianbo Zhang, Hua Hua, Research on scalp acupuncture combined with computer-aided training on cognitive impairment after cerebrovascular disease (in Chinese), Shaanxi J. Tradit. Chin. Med. (3) (2014) 353–354. CNKI:SUN:SXZY. 0.2014-03-060.
[28] Jianbo Zhang, Wei Ruipeng, Hong Yang, Yunxia Shen, Jie Zheng, Scalp acupuncture combined with computer-aided training for the treatment of cognitive impairment after cerebral infarction in the elderly (in Chinese). Magnetic resonance spectroscopy imaging, Chin. J. Gerontol. 19 (2020) 4067–4070. CNKI:SUN: ZLXZ.0.2020-19-011.
[29] Hua Hua, Bing Han, Jianbo Zhang, Observation on event-related potentials of scalp acupuncture combined with computer-assisted training in the treatment of cognitive impairment after cerebral infarction (in Chinese), Chin. Med. Innov. (17) (2016) 126–129. CNKI:SUN :ZYCX.0.2016-17-039.
[30] Jianbo Yu, Xiaofen Wu, Xiaomei Yang, Hongyan Qi, Baowen Yang, Ying Wang, Lijuan Zhang, Clinical observation of scalp acupuncture combined with computer-assisted training on the rehabilitation of cognitive impairment after brain injury (in Chinese), Chin. J. Rehabil. Med. (1) (2013) 36–39. CNKI:SUN: ZGKF.0.2013-01-011.
[31] Azhen Chen, Zhicheng Lin, Lan Lan, The effect of long-term scalp acupuncture retention combined with cognitive rehabilitation training platform on cognitive function after stroke (in Chinese), Massage Rehab. Med. (5) (2020) 22–23+26, https://doi.org/10.19787/j.issn.1008-1879.2020.05.009.
[32] Jianhong Li, Zhihu Yang, Jianfeng Yao, Jingchao Lu, Hong Zhou, The effect of acupuncture and moxibustion combined with computer-assisted cognitive training in the treatment of cognitive dysfunction after stroke (in Chinese), Ningxia Med. J. (9) (2019) 848–850, https://doi.org/10.13621/j.1001-5949.2019.09.0848.
[33] Wei Ruipeng, Jianbo Zhang, Wendong Cong, The effect of acupuncture on cognitive function after cerebral infarction and analysis of NHISS and ADL scores (in Chinese), Jilin Trad. Chin. Med. 10 (2019) 1373–1376, https://doi.org/10.13463/j.cnki.jlzyy.2019.10.029.
[34] Ying Guan, Li Ji, Lu Wang, Li Zhang, Luwen Zhu, Qiang Tang, The effect of acupuncture on homocysteine and cognitive function in patients with ischemic stroke (in Chinese), Chin. Rehab. Theory Pract. (3) (2019) 289–293.
[35] W.L. Hu, Y.C. Hung, C.H. Chang, Acupuncture for disorders of consciousness-A case series and review, Acupuncture–Clin. Pract., Part. Tech. Special Issues 1 (2011).
[36] L. Sun, Y. Fan, W. Fan, J. Sun, X. Ai, H. Qiao, Efficacy and safety of scalp acupuncture in improving neurological dysfunction after ischemic stroke: a protocol for systematic review and meta-analysis, Medicine 99 (34) (2020).
[37] E.J. Yang, S. Lim, J.Y. Kim, E. Lee, S.D. Lee, Scalp acupuncture improves cognitive function: a systematic review, J. Alternative Compl. Med. 16 (8) (2010) 803–807, https://doi.org/10.1089/acm.2009.0693. PMID: 20618035.
[38] Y. Zhao, S. Zhang, Q. Wu, Y. Huang, Scalp acupuncture for post-stroke cognitive impairment: a systematic review and meta-analysis of randomized controlled trials, Evid. base Compl. Alternative Med.: eCAM 2016 (2016), 4957950, https://doi.org/10.1155/2016/4957950. PMID: 27774120.
[39] W. Zhou, Y. Zhang, Y. Wu, G. Shi, A comparative study on the effect of cognitive training between computer-assisted cognitive rehabilitation therapy and occupational therapy for patients with stroke, Eur. Rev. Med. Pharmacol. Sci. 19 (3) (2015) 439–446.
[40] W. Li, R. Han, L. Guo, L. Li, Effect of computer-based cognitive rehabilitation on cognitive functions and neural reorganization in patients with cerebral infarction: a randomized controlled trial, Chin. J. Rehabil. Med. 32 (6) (2017) 600–604.