Breathing Exercises for Improving Influencing Cognitive Decline

Subjects: Rehabilitation
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Stroke is caused by a fall in blood supply to the brain or due to cerebral hemorrhage and is the most common cerebrovascular condition. With the increase in the average life expectancy as a result of lifestyle improvements and advances in health care, the number of patients with stroke has seen an upward trend. Furthermore, studies have shown a possible association between the coronavirus disease (COVID-19) and acute cerebrovascular diseases such as ischemic stroke, hemorrhagic stroke, and cerebral venous thrombosis. With the continuing COVID-19 pandemic, a steep increase in stroke incidence is therefore likely.

cerebrovascular disease  hemiplegia  stroke  cognitive function  breathing exercise

1. Psychological Factors and Breathing in Stroke

Post-stroke depression (PSD) is the most common neuropsychiatric complication in patients with stroke [1][2]. Studies report that approximately one in three patients with stroke exhibit PSD [3][4][5][6]. In a study on healthy older adults, breathing exercises were shown to have a positive effect on psychological functions [7][8][9]. In a study by Brown and Gerbarg, breathing exercises were suggested to be beneficial for patients with PSD [10]. Breathing exercises restore the normal state of the autonomic system by regulating the movement of the respiratory system. Moreover, enhanced parasympathetic nerve activity may lead to improvements in psychological as well as cognitive functions [11][12]. As the most significant positive effect of breathing exercises, enhanced parasympathetic nerve activity was shown to reduce the response to psychological stress and, consequently, exert positive effects on various domains across psychology, cognition, and behavior [13][14] (Table 1).

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Participants</th>
<th>Time and Duration</th>
<th>Type</th>
<th>Primary Outcome</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subbalakshmi et al. (2014) 10</td>
<td>Healthy adults, males and females</td>
<td>20 min, 1 time</td>
<td>Acute, Nadi-shoidhana Pranayama</td>
<td>Basal heart rate, systolic blood pressure, peak expiratory flow rate, respiratory, cardiovascular parameters</td>
<td>Reduced basal heart rate and systolic blood pressure, improved peak expiratory flow rate, no difference in respiratory and cardiovascular parameters</td>
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<tr>
<td>Udupa et al. (2003) 16</td>
<td>Normal young adults, males and females</td>
<td>20 min/d, 3 months</td>
<td>Long-term, Pranayama breathing</td>
<td>Parasympathetic and sympathetic activity</td>
<td>Decreased sympathetic activity, increased parasympathetic activity</td>
</tr>
</tbody>
</table>

Table 1. Effects of breathing exercises on psychological factors.
2. Vascular Factors and Breathing in Stroke

Stroke-induced damage to areas of the brain associated with autonomous function has a substantial influence on the blood pressure control and cardiac function during the period of recovery [17] [18]. In addition, patients showing post-stroke hemiplegia exhibited a markedly low level of residual blood flow in the paretic lower limb [19] [20] [21]. Such problems of vascular function can negatively affect the performance of activities of daily living (ADL) and the quality of life [22] [23]. Reduced physical activity can in turn affect the blood flow velocity, endothelial function, and arterial diameter through secondary reduction in blood flow [22] [24].

No study has yet directly investigated the effects of breathing exercise and respiratory function on vascular function in patients with stroke; however, several studies have been conducted on patients with hypertension, which is known to be the most serious risk factor for stroke incidence.

Breathing exercises are widely acknowledged as a non-pharmaceutical intervention for the control of hypertension, a risk factor of stroke [25] [26] [27]. The mechanism of action is as follows: the pressor receptor stimulating the autonomic nervous system during prolonged inhalation and exhalation increases the baroreflex sensitivity (BRS) and decreases the sympathetic activity and chemoreflex activation [28] [29]. In numerous studies, slow breathing exercises have shown positive effects on BRS, blood pressure, and autonomic nervous system function [28] [30] [31]. Hypertension is a particularly important risk factor for hemorrhagic stroke although it contributes to atherosclerotic disease that can lead to ischemic stroke as well, increasing the risk of stroke by approximately 2.87 times [32] [33]. The prevalence of stroke in hypertension patients aged 50 years or above was 20% of the total population, and the prevalence continuously increased with increasing age [34]. Based on the correlation between hypertension and stroke, further studies should be conducted to determine the effects of breathing exercises on the vascular function, blood pressure, and autonomic nervous system in patients with stroke (Table 2).

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<tr>
<td>Klainin-Yobas et al. (2015)</td>
<td>Normal young adults, males and females</td>
<td>30 min 2 times/d, 3 months</td>
<td>Long-term, slow breathing</td>
<td>Autonomic functions</td>
<td>Improved autonomic functions</td>
</tr>
<tr>
<td>Hyun et al. (2009)</td>
<td>Older adults, males and females</td>
<td>60 min/d, 3 times a week, 12 weeks</td>
<td>Long-term, Danjeon breathing</td>
<td>Vital capacity, physical fitness, anxiety, depression</td>
<td>Reduced anxiety and depression, no difference in vital capacity and physical fitness</td>
</tr>
<tr>
<td>Krishnamurthy and Telles (2007)</td>
<td>Older adults, males and females</td>
<td>75 min/d, 6 times a week, 24 weeks</td>
<td>Long-term, Pranayama breathing with yoga training</td>
<td>Depression</td>
<td>Reduced depression</td>
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</tbody>
</table>

Table 2. Effects of breathing exercises on vascular factors.
3. Sleep and Breathing in Stroke

Sleep-related breathing disorders occur in more than half of patients with stroke [25][26]. They are also an independent risk factor for stroke [27][28][29], while being responsible for the risk of stroke recurrence, mortality, and deterioration of cognitive function [30][31]. Sleep-related breathing disorders include habitual snoring, upper respiratory tract resistance syndrome, apneic periodic breathing, and sleep apnea syndrome. OSA refers to the partial or complete collapse of the upper airway during sleep, resulting in reduced or absent (or apnea) airflow lasting for 10 s [32]. Many OSA patients are highly likely to show cardiovascular or cerebrovascular diseases, as OSA is also associated with hypertension, a direct risk factor of stroke [33][34][35][36]. OSA is also associated with fibrinogen levels, a key independent risk factor for myocardial infarction and vascular diseases [37][38]. Elevated fibrinogen levels are correlated with increased risk of cardiovascular events in patients with stroke [39][40][41]. As OSA reduces the cerebral blood volume and decreases the blood supply to the brain, it is viewed as a risk factor for stroke [42].

In a study by Yaggi et al. conducted on 1022 adults with no history of stroke or myocardial infarction, the risk of stroke was shown to increase as the severity of OSA increased [43]. This result was verified in further follow-up studies and meta-analyses, where adults with OSA showed approximately a two-fold higher risk of stroke [44][45][46][47][48]. Additionally, untreated OSA after acute stroke increases long-term mortality and neurological outcomes [49][50], which highlights the importance of rapid treatment of post-stroke OSA.

The most well-known treatment of OSA in patients with stroke is continuous positive airway pressure (CPAP). While CPAP was shown to have positive effects on neuronal recovery, sleep,
depression, and long-term survival [55][56][57][58], patients with stroke show a reduced long-term compliance to CPAP compared to healthy individuals [59]. This may be related to the difficulty in wearing and retaining the CPAP mask due to weak upper extremity and face as well as due to depression [59]. CPAP also has a role in causing phobia related to rhinocleisis [60], the arousal of the respiratory tract related to oral exposure and drying of mucous membranes [61]; therefore, there are challenges in its successful application in patients with stroke. This suggests the need for simple interventions or treatment strategies for OSA.

Among the interventions to improve OSA are a diversity of breathing re-education (BRE) approaches. These include the Buteyko method, inhalation resistance breathing training, and diaphragmatic breathing [62][63][64][65]. The BRE approach aims to improve the abnormal breathing pattern in patients with chronic hyperventilation. It involves exercises such as breath-holding and controlled breathing to restore the normal nasal/diaphragmatic pattern and treat dysfunctional breathing habits, such as abnormal mouth breathing and abnormal apical breathing or upper chest breathing [66].

Mouth breathing is associated with the severity of OSA [67][68], as it plays a part in snoring, OSA, apnea, and hypopnea [68]. In addition, patients with OSA were reported to show reduced strength of the diaphragm and muscles related to breathing compared with age- and sex-matched controls [62]. In a study by Courtney, the magnitude and stability of respiratory motor output for muscles of the upper airway was reported to be a key contributing factor across all forms of sleep apnea [62].

The BRE approach of Mckeown, which applies the Buteyko method, includes the conversion of mouth breathing to nasal breathing during rest, exercise, and sleep [66]. Such breathing exercises play a part in restoring nasal breathing, enhancing the function of the diaphragm, reducing breathing rate, and increasing the tolerance to changes in arterial carbon dioxide pressure [69]. Recent studies have shown that the BRE approach improves breathing patterns and can be beneficial for OSA patients [62][70]. However, no study has investigated the effects of breathing exercises or the re-education approaches for OSA and other sleep-related disorders in patients with stroke, suggesting the need for relevant further studies (Table 3).

Table 3. Effects of breathing exercises on sleep factors.

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<tr>
<th>Author (Year)</th>
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<tr>
<td>Ojay and Ernst (2000)</td>
<td>Chronic snorers</td>
<td>20 min/d, 3 months</td>
<td>Long-term, diaphragmatic breathing and singing and exercises training</td>
<td>Snoring, nasal problem</td>
<td>Reduced snoring</td>
</tr>
<tr>
<td>Vranish and Bailey (2016)</td>
<td>OSA patients</td>
<td>5 min/d, 6 weeks</td>
<td>Long-term, inspiratory muscle training</td>
<td>Respiratory muscle strength, sleep, snoring, inflammation, metabolism</td>
<td>Improved respiratory muscle strength and improved sleep, reduced inflammation, improved metabolism</td>
</tr>
<tr>
<td>Birch (2021)</td>
<td>Practitioners and OSA patients</td>
<td>15 min 3 times/d, 2 weeks</td>
<td>Short-term, breathing retraining (Buteyko berating exercises)</td>
<td>Sleep, breathing pattern, general health, quality of life</td>
<td>Improved sleep, improved breathing pattern, improved general health, improved quality of life</td>
</tr>
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<td>Birch (2004)</td>
<td>44-year-old male (with asthma, severe COPD, OSA) (Case study n = 1)</td>
<td>15 min 3 times/d, 2 years</td>
<td>Long-term breathing retraining (Buteyko breathing exercises)</td>
<td>CPAP, OSA</td>
<td>Improved CPAP, improved OSA</td>
</tr>
</tbody>
</table>

References


Fonkoue, I.T.; Marvar, P.J.; Norrholm, S.D.; Kankam, M.L.; Li, Y.; DaCosta, D.; Rothbaum, B.O.; Park, J. Acute effects of device-guided slow breathing on sympathetic nerve activity and


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