



CHAPTER 7

DISCUSSION

7.0 DISCUSSIONS

7.1 SUMMARY

This is the first randomized control trial of yoga in SCI. The aim of the present study was to compare the effect of IYP to PT in the management of SCI patients on ASIA score, functional independence, distress, an inflammatory marker, quality of life and body mass index.

The percentage change in the post scores of ASIA, BMI, SCI-QoL, SCIM, MEDS, and CRP is higher in IYP than the PT group, when compared with pre scores. Similarly, between groups comparison showed IYP group had significantly better improvement in SCI-QoL, MEDS, and CRP than PT group, which suggests that yoga therapy could be a feasible, cost-effective, easy-to-accomplish, non-pharmacological intervention aiding rehabilitation of paraplegics.

7.2 MECHANISM

A possible mechanism is explored hereunder.

7.2.1 Effect of Add-on of Yoga on Psychological Parameters in SCI patients:

The non-pharmacological approach of yoga therapy (Narasimhan, Nagarathna, & Nagendra, 2011; Rajesh, Ilavarasu, Srinivasan, & Nagendra, 2014) which encompass a combination of physical postures, voluntary breathing practices, cleansing techniques, concentration and relaxation techniques (Rakhshani, Maharana, Raghuram, Nagendra, & Venkatram, 2010). As observed in the outcomes, the positive changes in the IYP group compared to the PT group may be due to psychological benefits; calming effect, increasing awareness, attention span, acceptance, adaptability, and a sense of security resulting from the practice of yoga therapy (Nagendra, 2013). The process adopted during

the yoga program included stimulation and successively followed by relaxation might have helped in breaking the loop of the uncontrolled speed of thoughts (stress) (Math & Srinivasaraju, 2010) and better psychological health resulting from stress reduction (Manzoni, Pagnini, Castelnuovo, & Molinari, 2008) through slowly gaining mastery over the mind (Deshpande, Nagendra, & Raghuram, 2008). Increase in thalamic GABA levels, improvement in mood and anxiety levels, and a decrease in depressive symptoms has been demonstrated by 12 weeks of yoga practice, in two recent studies (Streeter, Gerbarg, Saper, Ciraulo, & Brown, 2012; Chris C Streeter et al., 2010). Emotional distress is well managed by yoga which is reflected in the reduction of symptoms score of MEDS. Improvement in emotional distress results in decreased sympathetic activity and may be attributed to better autonomic modulation. The function of the autonomic nervous system (ANS) becomes more specific resulting in a tilt in balance in favor of the parasympathetic nervous system (PNS), in turn resulting in emotional stability and distress reduction (Meyer et al., 2012). Previous studies have shown that yogic practices handle anxiety and depression well, resulting in enhanced self-esteem & betterment in performances of activities of daily living (ADL) (Woodyard, 2011). A 6-week specialized yoga program has shown similar results where there have been significant improvements in depressive symptoms, mindfulness, and self-compassion in yoga group compared to control (Curtis et al., 2017). Thus, improvement in SCI-QoL Index can be attributed to improvement in psychological states due to yogic practices.

7.2.2 Effect of Add-on of Yoga on Inflammatory Markers in SCI patients:

There is strong evidence showing an association of raised CRP with chronic SCI, which is mainly due to prevailing systemic inflammation and not due to any infection condition (Frost et al., 2005; Gibson et al., 2008; Wang et al., 2007). As per the study protocol, we

wanted to observe whether the add-on of yoga therapy does improve chronic systemic inflammation in patients who have already undergone their primary rehabilitation.

The reduction in CRP scores indicates a significant reduction in systemic inflammation in the IYP group in comparison to the PT group. Reduction in inflammation can be directly attributed to a significant decrease in stress in the IYP group. Yoga has a beneficial impact on reducing stress than simple exercises, as shown in previous studies (Rao et al., 2009). Relaxation and calming effects are unique to yoga, which in turn helps to modulate Hypothalamus-Pituitary-Adrenal-Axis (HPA-axis) and resulted in reducing inflammation (Bower et al., 2014). It is likely that yoga practice improves immune function (Aravind Gopal, Sunita Mondal, Asha Gandhi, Sarika Arora, 2011) and this could add to bring a significant change in the parameters measured.

By reducing the activation and reactivity of the sympathoadrenal system and the hypothalamic-pituitary adrenal (HPA) axis and promoting feelings of well-being, Yoga may alleviate the effects of stress and bring up multiple positive downstream impact on neuroendocrine status, metabolic function, and related systemic inflammatory responses. These results may also explain the improvements in pain and reduction in ESR values in IYP more than PT.

7.2.3 Effect of Add-on of Yoga on Gait and Functional Independence in SCI patients:

Our study reported the functional improvement (in areas such as self-care, respiration, sphincter management, and mobility) is better in IYP group (% change=17.35%) as indicated by SCIM scores as compared to PT group (% change=5.64%), though no significant differences were observed in between the two groups. This finding aligns with the results of another clinical trial on paraplegics where there was a highly significant

improvement in spasticity and gait after receiving yoga therapy (Madhusmita et al., 2018).

Muscle conditioning during yoga's intense stretching postures helps by improving oxidative capacity and strength of skeletal muscles, flexibility, endurance, coordination, power, static and dynamic stability, decreasing glycogen utilization, in turn improving physical performance and increasing walking pace and stride length (Katiyar & Bihari, 2006). This possibly explains the improvement in scores of Walking index for SCI (WISCI II) and shows a significant difference between the groups post-intervention.

Yoga postures (*asanas*) are targeted to extend the spine in controlled measures and also to twist the spine gently. These *asanas* could increase blood flow in the spinal arteries and thus bring improved oxygen with increased healing possibilities, as demonstrated by a previous study (Zwick, 2006). Neural tissue plasticity can be promoted by several factors including neurotrophic factors, neurotransmitters, endocrines, cytoskeleton proteins, and neuronal electrical activity to name a few (Raju, 2017). The practice of yoga can enhance the above-mentioned factors and could have possibly increased the production of neurotrophic factors (.e.g. – BDNF, VEGF, IGF-1, etc.) that would have mediated neurogenesis and neuroplasticity (Denham, Marques, O'Brien, 2014; Steinmann, 2004). This, in turn is likely to improve sensory, motor and autonomic function in SCI patients. Hence, the current study clearly showed that because of add-on of yoga therapy, improvements in IYP group were better than the PT group.

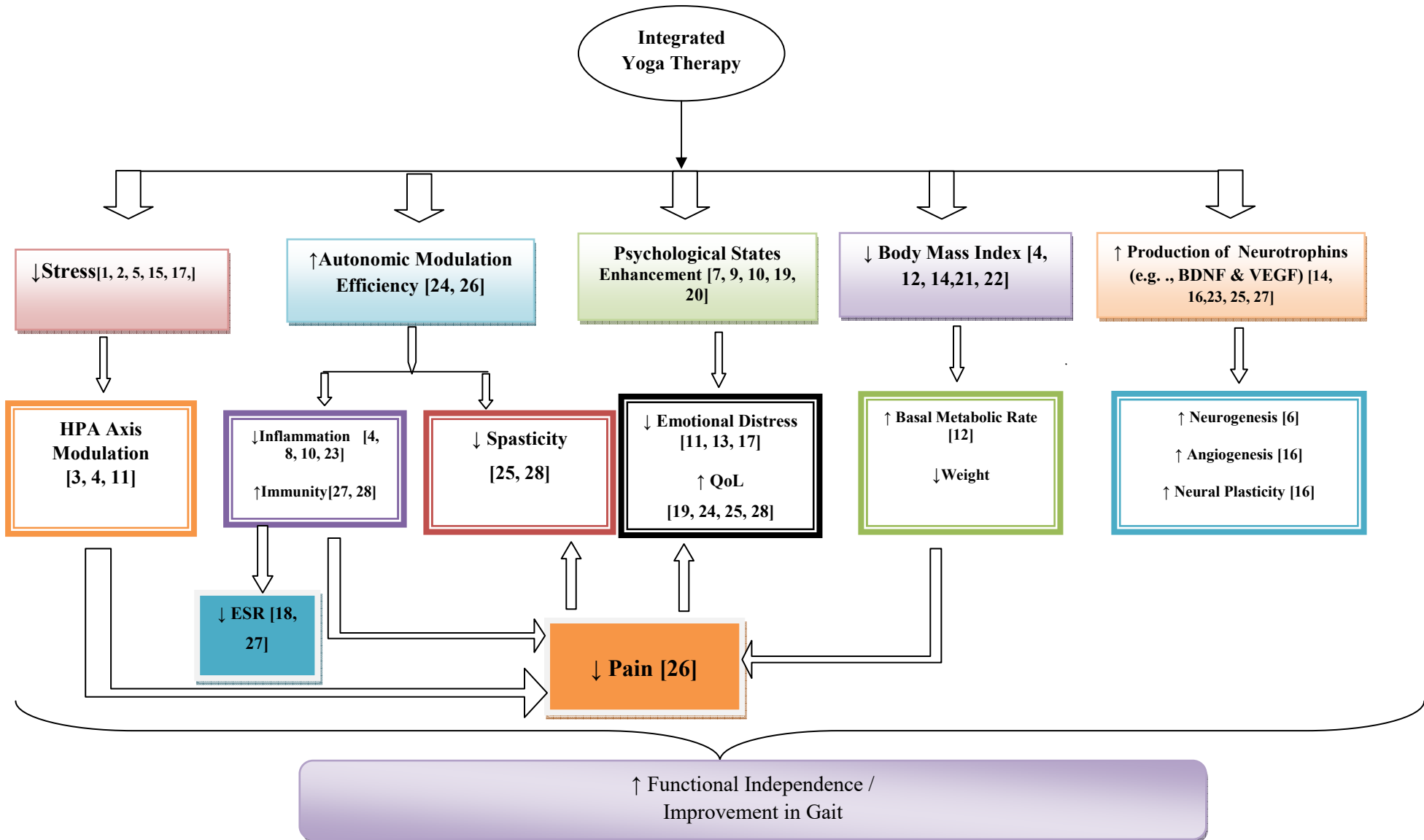
7.2.4 Effect of Add-on of Yoga on Spasticity and Metabolism in SCI patients:

Deep relaxation technique, an important component of Yoga therapy, showed significant reductions in the yoga group's spasticity, possibly due to modulation of cardiac autonomic function and cardio-respiratory efficiency (Ranjita, Hankey, Nagendra, & Mohanty, 2016). It may also synchronize neural elements in the brain, leading to ANS changes,

resulting parasympathetic dominance and blunted sympathetic activity leading to reduced spasticity. Pranayama modifies various inflation and deflation lung reflexes and interacts with central neural elements to improve homeostatic control (Tandon, Tripathi, 2012).

Though both groups (IYP and PT) showed improvements in the scores of BMI and ASIA, the magnitude of change was higher in participants of IYP group compared to participants of the PT group. This indicates that add-on of yoga therapy with physiotherapy, increases basal metabolic rate, enhancing metabolism and more fat oxidation (Sengupta, 2012). Therefore, better metabolic regulation has resulted in weight reduction and improvement in sensory and motor function leading to better mobility.

Figure 16. Summarizes possible mechanisms for add-on yoga module in improving patient outcomes in SCI.



[Figure 16; Source: 1. Arora, Bhattacharjee, Gopal, Mondal, & Gandhi, 2011, 2. Bhargav, Nagendra, Gangadhar, & Nagarathna, 2014, 3. Bower et al., 2014, 4. Deshpande, Nagendra, & Raghuram, 2008, 5. Gazdic et al., 2018, 6. Harinath et al., 2004, 7. Katiyar & Bihari, 2006, 8. Krishnakumar, Hamblin, & Lakshmanan, 2015, 9. M. R. Rao et al., 2009, 10. Meyer et al., 2012, 11. Nielsen, 2003, 12. Nuttall, 2015, 13. Overholser, Schubert, Foliart, & Frost, 1993, 14. Rael Cahn et al., 2017, 15. Rajesh, Ilavarasu, Srinivasan, & Nagendra, 2014, 16. Raju, 2017, 17. Raju, 2017, 18. Sathyaprabha et al., 2008, 19. Rakhshani, Maharana, Raghuram, Nagendra, & Venkatram, 2010, 20. Ranjita, Hankey, Nagendra, & Mohanty, 2016, 21. Rao, Metri, Raghuram, & Hongasandra, 2017, 22. Sengupta, 2012, 23. Steinmann, 2004, 24. Streeter et al., 2010, 25. Streeter, Gerbarg, Saper, Ciraulo, & Brown, 2012, 26. Telles et al., 2017, 27. Wang et al., 2007, 28. Woodyard, 2011].