

CHAPTER 6

RESULTS

6 Results

6.1 Baseline characters of subjects in the groups

There was no statistical significance between the groups in terms of age, gender distribution, Body Mass Index (BMI), cardiac parameters found at the baseline (Table 10).

Table 10: Baseline characteristics of the groups

Variables	IAYT	Non-IAYT	P value ^a
No of subjects	N=20; F=5 , M=15	N=20; F=7 , M=13	NS
Age(Mean) years	46.62±9.9	47.08±9.69	0.13
HR (bpm)	78.21±12.21	76.64±13.21	0.45
SBP (mmHg)	135.23±11.37	130.72±11.32	0.08
DBP (mmHg)	77.38±9.56	74.14±9.91	0.09
BRS 9ms/mmHg	6.30±1.63	6.43±1.60	0.13
TPVR	1427.24±166	1495.73±156.81	0.15
DLST Score	39.52±11.70	38.27±11.02	0.479
DF Score	4.30±1.23	4.67±1.27	0.113
DB score	3.73±1.01	3.93±1.20	0.433
BMI (kg/M ²)	25.45±5.86	26.27±4.15	0.13

HR-Heart rate, SBP-Systolic Blood pressure, DBP-Diastolic blood pressure, BRS-Baroreflex sensitivity, TPVR- Total peripheral vascular resistance, DLST-Digit Letter Substitution test, DF-Digit forward, DB-Digit backward, BMI-Body Mass Index. ^ap values after Independent sample t test.

Mean values of systolic and diastolic blood pressure were within normal limits, this could be due to antihypertensive medication. Similarly, scores were found in one of the previous studies by A study by Anand Bala Yogi - mean Systolic blood Pressure of 23 subjects at baseline was 136.13 ± 3.32 and diastolic blood Pressure 77.83 ± 1.48 .

Within group comparison

Changes in cardiac variables

In IAYT group

After one week of IAYT intervention we found a significant decrease in systolic blood pressure ($p=0.004$), diastolic blood pressure ($p=0.008$), mean arterial pressure ($p=0.03$), baroreflex sensitivity ($p<0.001$) and total peripheral vascular resistance ($p=0.007$) compared to baseline (Shown in table 11). But there was insignificant decrease in heart rate ($p=0.665$). Further, these studies indicate the significant improvement in cardiac variables. Reduction in the systolic, diastolic and mean arterial blood pressure is the most important & primary outcome in hypertension. Increase in the baroreflex sensitivity indicates the improvement in cardiac autonomic functioning also peripheral vascular resistance in a significant direct contributor in blood pressure elevation our finding showed a significant decrease in total peripheral vascular resistance following one week yoga intervention.

Non-IAYT group

In contrast to IAYT group, Non-IAYT intervention group showed no significant improvement in any of the cardiac parameters assessed after one week compare to baseline.

Between groups comparison

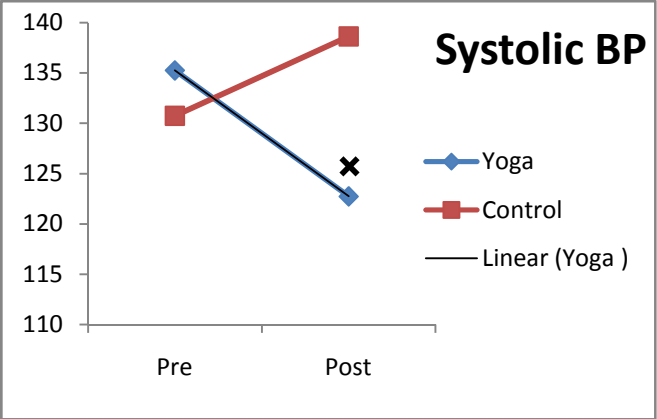
There was no significant difference found in preintervention comparison between both the groups hence both the groups were comparable at baseline. Post intervention between group comparison showed a significant improvement in systolic blood pressure ($p=0.038$), baroreflex sensitivity ($p=0.034$) and total peripheral vascular resistance ($p=0.015$) in IAYT group compared to Non-IAYT group (Shown in table 13).

Table 11: Within group and between groups Prepost changes in IAYT & Non-IAYT groups

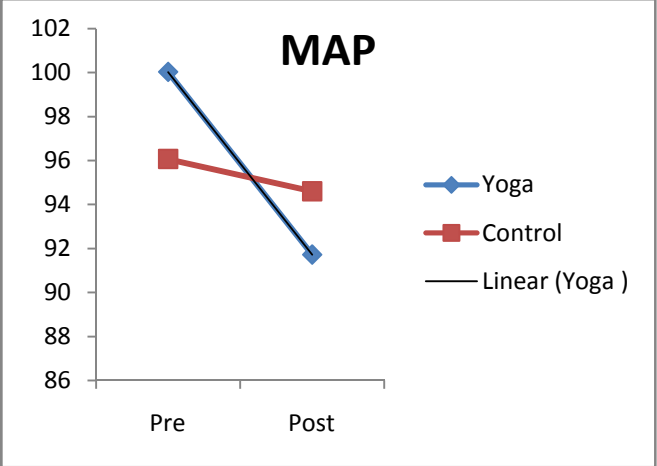
Parameters	IAYT group				Non-IAYT group				Between group comparison
	Pre (Mean±SD)	Post (Mean±SD)	% Change	P ¹ value	Pre (Mean±SD)	Post (Mean±SD)	% Change	P ¹ value	P ² value
Heart rate (bpm)	78.21±12.2 1	77.11±11.21	-1.41	0.665	76.64±13.21	75.51±12.79	-1.47	0.72	0.579
SBP (mmHg)	135.23±11.37	122.73±8.9	-9.24	.004	130.72±11.32	138.62±10.77	6.04	0.10	.041
DBP (mmHg)	77.38±9.56	71.45±6.537	-7.66	.008	74.14±9.91	76.16±8.95	2.72	0.32	0.095
Mean Arterial pressure (mmHg)	100.02±10.1	91.722±7.1	-8.30	0.003	96.060±10.21	94.60±9.2	-1.52	0.33	0.298
Cardiac output (ml/minute)	6.55±0.43	6.76±0.38	3.21	0.46	6.09±0.25	6.19±0.31	1.64	0.87	0.557
Stroke volume (ml/stroke)	84.95±5.74	85.98±4.67	1.21	0.826	80.61±3.39	83.88±4.88	4.06	0.48	0.785
Baroreflex sensitivity (ms/mmHg)	6.30±0.74	8.97±0.92	42.38	0.001	6.43±0.60	6.61±0.57	2.80	0.15	.001
Peripheral vascular resistance dyn·s/cm⁵	1427.24±16	1036.94±135	-27.35	.007	1495.73±156.81	1347.01±134.83	-9.94	0.60	.027

¹ within group prepost changes after one week. ² Post intervention between group difference, * indicates. Table shows mean & SD of all the cardiac variables at baseline and after one week. ¹ within group prepost changes after one week. ² Post intervention between group difference, * indicates the statistical significance level at 0.01 & ** indicates the statistical significance level at 0.001

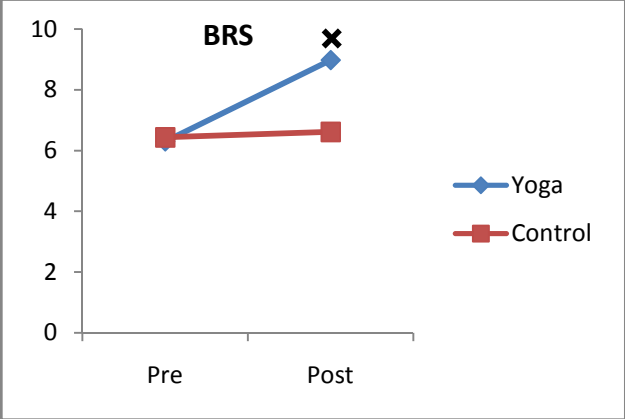
Graph 1: Prepost changes in Systolic blood pressure in IAYT & Non-IAYT groups blood pressure in yoga and control group.



Graph 2: Prepost changes in mean arterial pressure in yoga and control group



Graph 3: Prepost changes in baroreflex sensitivity in yoga and control group



Graph 4 : Prepost changes in total vascular resistance in yoga and control group

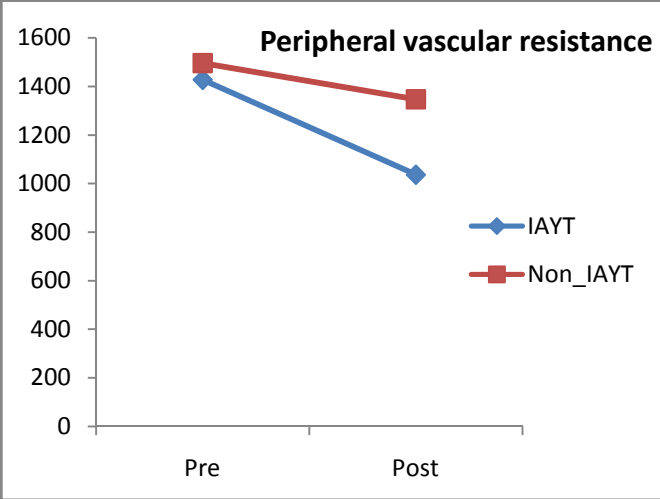


Table 12: Effect size for all the variables.

Groups	Cohen's d
Heart rate	0.84
Systolic BP	3.2
Diastolic BP	2.04
Mean Arterial pressure	0.91
Cardiac out put	1.6
Stroke volume	0.44
Baroreflex sensitivity	3.08
Peripheral vascular resistance (Pas.s/m³)	2.29
Anxiety	0.86
Depression	0.42
DF	1.42
DB	0.93
DLST	0.58

This table indicates the large effect size (>.8) in heart rate, systolic & diastolic BP, mean arterial BP, cardiac output, baroreflex sensitivity, Peripheral vascular resistance, anxiety, Digit Forward & backward. Effect aize is medium (>.5<.8)in variables stroke volume & Digit letter substitution test.

Psychological variables [Table 3]

Within group comparison

IAYT group

There was a significant decrease in anxiety ($p < 0.001$, -40%) and depression ($p = 0.003$, -27%) following one week of IAYT intervention compared to baseline.

Non-IAYT group

Non-IAYT group no significant difference was found in anxiety ($p = 0.64$, -0.8 %) and depression ($p = 0.64$, 1.7 %) after one compared to baseline.

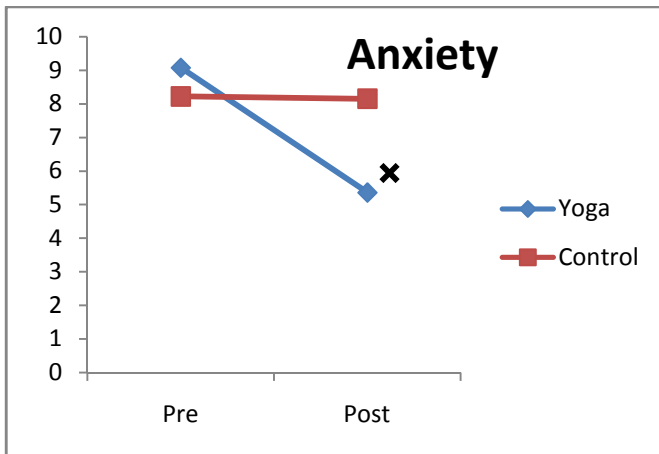
Between group comparison

Between groups post intervention comparisons showed a significant decrease in anxiety ($p < 0.001$) and depression ($p = 0.04$) score in IAYT group compared to Non-IAYT group.

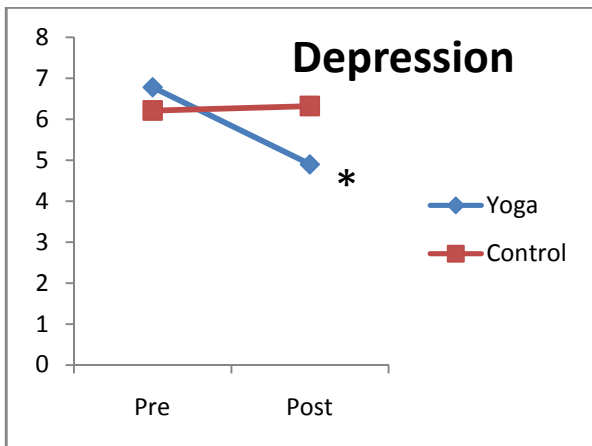
Table 13: Pre-post changes in Anxiety and depression in within group and between group after one week.

Variables	IAYT group				Non-IAYT grup				Between group
	Pre Mean± SD	Post Mean± SD	% change	P value	Pre Mean ± SD	Post Mean ± SD	% change	P value	P value
HADS-Anxiety scores	9.07±4.36	5.36±3.31	- 40	<0.001	8.22±2.82	8.15±3.15	-0.8	0.64	<0.001
HADS- Depression scores	6.78±4.07	4.90±3.25	- 27	0.003	6.21±3.51	6.32±3.42	1.7	0.44	0.04

Graph 5: Prepost changes in anxiety in yoga and control group



Graph 6: Prepost changes in depression in yoga and control group



* Indicates the significant changes

Cognitive variables

Within group comparison

IAYT group

We observed a significant improvement in digit forward ($p < 0.001$) and digit backward ($p < 0.001$) span, DLST total attempt ($p = 0.005$) and DLST net attempt ($p = 0.006$) after IAYT intervention compared to baseline.

Non-IAYT group

There was a significant decrease in DLST net score ($p = 0.03$), and no significant changes were found in total and net score of DLST non-IAYT group

Between group comparison

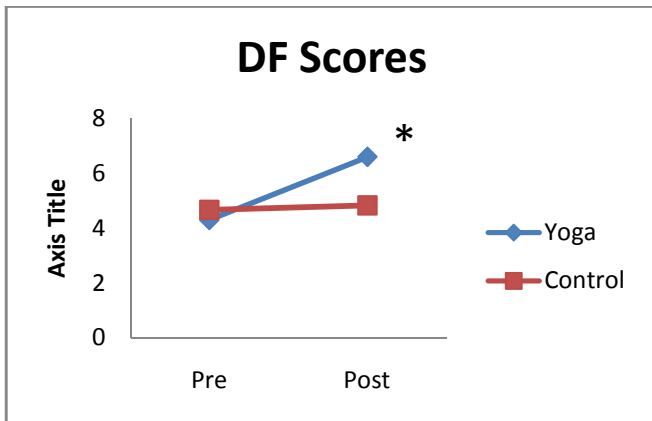
Between group comparison showed a significant improvement in digit forward ($p < 0.001$) and digit backward ($p < 0.001$) test, DLST total attempt ($p < 0.001$) and DLST net attempt ($p < 0.001$) in the IAYT group as compared to non-IAYT group. The improvement in DLST score is suggestive of increased attention, concentration, psychomotor speed following one week IAYT intervention.

Table 14: Changes in Digit memory test and DLST before and after one week in IAYT group and non-IAYT group and IAYT Vs Non-IAYT group

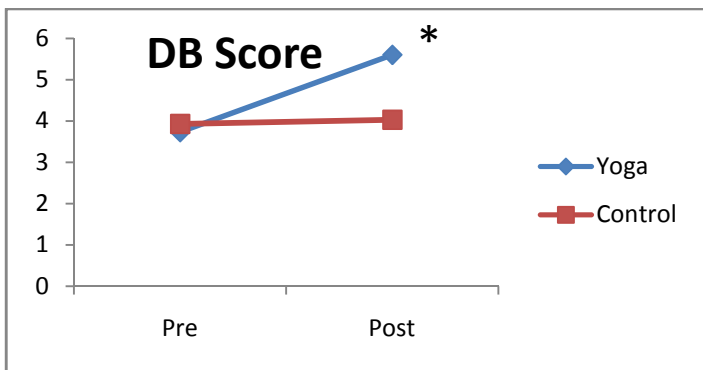
Variables	IAYT group				Non-IAYT grup				Between group
	Pre Mean± SD	Post Mean± SD	% change	P value	Pre Mean ± SD	Post Mean ± SD	% change	P value	P value
DF Span	4.30±1.23	6.60±1.35	53.49	<0.001	4.67±1.27	4.83±1.18	3.43	.902	<0.001**
DB Span	3.73±1.01	5.60±1.35	50.13	<0.001	3.93±1.20	4.03±1.10	2.54	.889	<0.001**
DLST TL	39.52±11.70	42.52±12.53	7.59	0.005	3.93±1.20	4.03±1.10	-6.25	0.052	<0.001**
DLST WA	0.14±0.35	0.12±0.4	-14.29	.12	0.30±0.47	0.60±0.67	33.30	0.072	0.052
DLST NT	39.98±11.8	42.38±12.5	7.62	0.006	37.27±10.94	35.28±11.78	-7.08	0.03	<0.001**

DLST; Digit Letter Substitution test, DF; Digit Forward, DB; Digit Backward, SYS; Systolic BP, Dia; Diastolic BP, HR; Heart rate, * Statistical significance at 0.01 level, ** Statistical significance level at 0.001 level

Graphs 7: Prepost changes in short term memory in yoga and control group

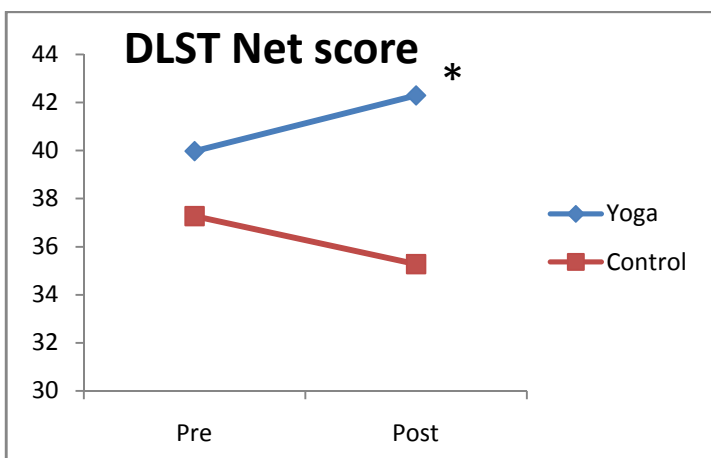


Graph 8: Prepost changes in working memory in yoga and control group



* Indicates the significant changes

Graph 9: Prepost changes in DLST net score in yoga and control group



* Indicates the significant changes

CHAPTER 7

DISCUSSION

7 Discussion

Aim of the present study was to assess the effect of one week IAYT intervention on cardiac variables, anxiety, depression and cognitive functions in subjects with hypertension. We found a significant improvement in systolic, diastole and arterial blood pressure, baroreflex sensitivity & total peripheral vascular resistance in intervention group compared to control group after the study. We found no significant change in heart rate, cardiac output and stroke volume in the IAYT and No-IAYT group this could be due to short term intervention.

Discussion on cardiac variables

In our study significant improvement was found in systolic blood pressure was found but heart rate showed no significant decrease which is quite surprising. Many studies have shown decrease in the heart rate after yoga intervention (Murgesan, 2000; Innes, 2005), and there are some studies which showed significant increase in heart after yoga intervention (Raghuraj, 2008), these contradictory findings are due to variation in the intensity and duration of the yoga intervention in the studies. Though our study did not show significant decrease in the heart rate but we can see the trend towards decrease after intervention. Further, it is quite surprising to see significant decrease heart rate despite of significant decreased in the systolic and diastolic blood pressure, similar findings were reported by Punita, 2015 in which there was a significant decreased in systolic and diastolic blood pressure along with no significant decrease in heart rate in hypertensive persons.

The improvement in systolic, diastolic and arterial blood pressure found in our study is consistent with the findings of previous randomized controlled trial by Chu et al, 2016(Chu,2016) which assessed effectiveness of yoga on modifying cardiac risk factors & metabolic syndrome parameters showed -5.84 & -4.99 mmHg decrease in systolic and

diastolic blood pressure. Another study by Cohen et al, demonstrated a significant improvement in systolic blood pressure, diastolic blood pressure following 6 weeks of Iyengar yoga intervention compared to usual care. Another study Moa et al found a significant improvement in diastolic blood pressure following 12 weeks of yoga.

Consistent with this study we also noticed significant decrease in blood pressure following one week of IAYT intervention. However, duration of intervention in our study is short compared to previous study but the intensity, content and frequency of the yoga intervention in our study is more than the previous studies.

In this study we assessed baroreflex sensitivity and peripheral vascular resistance which are directly involved in blood pressure control. After IAYT intervention we observed significant increase in baroreflex sensitivity and significant decrease in total peripheral vascular resistance. Our findings are consistent with the previous findings by Bowman A, 1997; in this study 6 weeks of yoga intervention improved baroreflex sensitivity in elderly persons, whereas practice of aerobic exercises for same duration in similar population did not improve baroreflex sensitivity (Bowman, 1997). Similarly we also found significant improvement in baroreflex sensitivity. Another study by O Parshad, 2011, sixty-four healthy students of average age 21.3 years underwent six weeks of yoga practice (one session/week) post intervention a significant decrease in systolic and diastolic blood pressure, mean arterial blood pressure, cardiac output, stroke volume and total peripheral vascular resistance was observed (Parshad, 2011) the results of the present study are also consistent with the previous findings.

To the best of our knowledge none of the earlier studies have assessed the efficacy of yoga in improving total peripheral resistance in hypertension. It is surprising to observe that there significant increase in the the baroreflex sensitivity but no significant decrease in the heart rate. Similar observation was noted in the previous study by Chacko N, 2005 in which significant

decrease in baroreflex sensitivity but no change in heart rate was found. The exact reason for such find is not clear but it may be due short-term intervention could be one of the reasons for such observation.

Discussion on cognitive functions

Cognitive decline is very commonly observed in hypertension. Attention and processing speed are the most commonly affected facets of cognition in HTN. In our study we found significant improvement in attention, concentration and processing speed following one week IAYT intervention compared to control group. Previously several studies have reported improvement in cognitive function following yoga practice in health and clinical population. A study by Sharma et al, 2006, found a significant improvement in cognitive function in patients having major depression following 8 weeks of Sahaj yoga practice along with anti-depressant medication compared to subjects who received only anti-depressant therapy (Sharma,2006)

Another study by Oken et al, 2004, observed a significant improvement in alertness and attention (by stroop test) following 6 months of Hath yoga practice (once a week with followed by home practice) compared to exercise group and waitlist control group in subjects suffering from multiple sclerosis (Oken BS, 2004).

A study by Rocha et al, compared the effects of six months yoga vs physical exercise in amry persons. Significantly better improvement in yoga group was observed in short term and long term memory compared to physical exercise group. Similarly we also found improvement in short term and working memory following one week of IAYT.

Findings of the present study also consistent with these previous studies. However, to the best of knowledge no previous studies reported the impact of yoga on cognitive functions in hypertension. In our study we found significant improvement following one week of IAYT intervention which is suggestive of potential role of yoga as a preventive measure for cognitive

decline in hypertension. There can be several mechanisms for improvement in cognitive function in IAYT group.

Discussion on psychological variables

A study by Nidhi, 2006 reported a significant improvement in state anxiety following 10 days of comprehensive integrated yoga intervention in subjects suffering from chronic health problems including hypertension. Another study Sharma, 2006 found significant improvement in depression and cognitive function following 8 weeks of sahaa yoga meditation in subjects with depression. Similarly in our study also we found significant improvement in anxiety and depression following one week IAYT.

To the best of our knowledge, this is the first study in which effect of IAYT in hypertension is assessed.

Literature suggests the significant role of anxiety and depression in development, maintenance and complicating the hypertension. This indicates treatment mere control of blood pressure is not adequate treatment of hypertension. Comprehensive management of hypertension should include interventions which address the psychological domains also. Yoga being mind-body intervention has its beneficial effects on both body and mind. Earlier studies of yoga have confirmed the role of yoga in management of various aspects of yoga including blood pressure, heart rate variability etc.

7.1 Mechanism

There can be several mechanisms through which improvement in cardiovascular, cognitive variables and anxiety & depression are found. Some of the possible mechanism can be as follows.

1. Yoga reduces sympathetic activity and enhances the parasympathetic tone via downregulation of hypothalamo-pituitary-adrenal axis (Streeter, 2012). This autonomic modulation following yoga helps in reducing blood pressure (Bernadi, 2001). Increased parasympathetic activity is associated with increased baroreflex sensitivity and reduced peripheral vascular resistance (Bowmen, 1997; Prashad, 2011). Different stretching postures in yoga might have reduced the arterial stiffness and contributed to decrease in the blood pressure. Decrease in the peripheral vascular resistance is also indication of decrease in sympathetic ton (Parshad, 2011).
2. In this study we found significant decrease in anxiety and depression after one week of yoga intervention. Repeated practice of relaxation technqies and yoga reported to reduce stress and anxiety. Reduction in the anxiety is associated with reduced HPA axis activity and associated sympathetic tone (Streeter, 2012).
3. Cognition function has negative coorelation with anxiety. In our study we found decrease in anxiety following IAYT. Enhancement in cognition could be indirect effect of anxiety reduction following IAYT (Sharma, 2006). There is negative association of stress and anxiety with cognition. Practice of yoga reduces the stress and anxiety this might have helped in improving cognitive abilities.
4. Various components of yoga such as asanas, pranayama, and meditation require continuous attention on body parts and breathing movement which is associated with increase in attention and concentration (Subramanya & Telles, 2009).

CHAPTER 7

CONCLUSION

Conclusion

Present study indicates the positive role of IAYT intervention on cardiac parameters, psychopathologies and cognitive functions among the subjects with essential hypertension. However, future studies should be done with larger sample size and with a robust research design to confirm the findings of present study.