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A CLINICAL STUDY ON THE EFFECT OF *BOERHAAVIA DIFFUSA (PUNARNAVA)* IN ESSENTIAL HYPERTENSION

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KEYWORDS: Essential Hypertension, *Boerhaavia diffusa, (Punarnava)*, Hydrochlorothiazide, Clinical Study.

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ABSTRACT

Essential Hypertension (EHTN) has already emerged as a non-communicable pandemic with considerable public health challenges. Its prevalence in India ranges from 20-40% in urban adults and 12-17% among rural adults which is rapidly increasing. The present clinical study was an approach to evaluate the efficacy of *Punarnava* (*Boerhaavia diffusa*) (BD) capsules in mild EHTN. 60 patients were randomly selected and divided into two groups. Their blood pressure (BP) measurement, serum urea & creatinine, total cholesterol, serum Na^+ & K^+, ECG & X-ray Chest (PA view) were done before and at the end of the treatment. Group T was given the trial drug (each capsule containing 250 mg of BD extract) in a dose of 2 capsules twice daily with water for six weeks. Group C was given the control drug (each tablet containing 12.5 mg of Hydrochlorothiazide (HCTZ) in a dose of 1 tablet once daily in the morning with water for six weeks. BD was found effective in reducing both systolic & diastolic blood pressure with statistical significance & also significantly improved the subjective complains in EHTN. Moreover it was well tolerated by most of the subjects and did not produce any harmful side effects.

INTRODUCTION

It is true that the modern lifestyle has drastically changed the way we live. Record agricultural harvest, rapid industrialization & scientific breakthroughs in different fields have really enhanced our standards of living. New working culture with limited physical activity, processed fast foods, passive forms of entertainment, almost no leisure, fragmented family life, degraded moral, social, spiritual & ethical values are now inevitable parts of our faster life which ultimately results in dangerous outcomes like physical & mental stress, repetitive strain injuries (RSI) and different lifestyle related diseases. Hypertension is one such outcomes of modern lifestyle.

Essential Hypertension has already become the most common cardiovascular disease. It is a major risk factor for congestive cardiac failure (CCF), ischemic heart disease (IHD), chronic renal failure (CRF) and stroke [1-2]. As much as 1 billion individuals worldwide are suffering from hypertension and approximately 7.1 million deaths per year are caused by hypertension. According to the World Health Organization (WHO) report, suboptimal BP (>115 mmHg of Systolic BP) is responsible for 62 % of cerebrovascular disease and 49 % of IHD, with little variation by sex. Not only this but also suboptimal BP is the number one attributable risk factor for death throughout the world [3]. EHTN has emerged as a major public health challenge for developing countries like India. The prevalence of hypertension in India ranges from 20-40% in urban adults and 12-17% among rural adults. The number of hypertension cases was approximately 118 million in 2000 which will dramatically jump to 214 million in 2025 as per estimation and will involve nearly equal numbers of men and women [4].

Various allopathic drugs are available at present to treat hypertension. Though these drugs are effective to certain extent in controlling EHTN, they also have their own limitation in terms of safety, side effects and economy. Therefore the need of the hour is to meticulously search for safe & effective alternative medications for management of EHTN. Way back in 1980, WHO has also emphasized the evaluation of the effectiveness and safety of plant products in conditions where no safe modern drugs are available. The present study is a stepping stone in herbal antihypertensive research initiatives.

Punarnava (Boerhaavia diffusa) is a very popular herb in entire *Ayurvedic* fraternity. Its use as a diuretic to cure renal problems is very common and proved beyond doubt [5]. However scientific reviewers have assigned many other important pharmacological activities like stomachic, digestive, anti-spasmodic, hepatoprotective, haematinic, anti-asthmatic, anti-inflammatory, anti-diabetic etc to this medicinal plant [6]. But a recent study published during May 2012 in the International Journal of Pharmaceutical Science & Research (IJPSR) found

Punarnava to be effective in hypertension by Ca 2+ channel antagonising effect in experimental models without any undue effect on normal blood pressure [7]. The results of this study was the encouraging foundation for the current clinical study to evaluate the effectiveness of *Punarnava* in mild (Stage – 1) cases of EHTN.

MATERIALS & METHODS

The present study was a single blind, simple, randomized, controlled clinical trial. A total of 60 ambulatory patients were selected from the OPD of Gopabandhu Ayurveda Mahavidyalaya & Hospital, Puri, Odisha during the period June 2012 to June 2013 and randomly allocated into two groups. Group - T contained 30 subjects and they were treated with the trial drug i.e. *Boerhaavia diffusa* (BD) Capsules. Group - C also contained 30 subjects and they were treated with the control drug i.e. Hydrochlorothiazide (HCTZ) Tablets. BD produces its appreciable effect in 30 days or so[8]. Therefore a reasonable treatment period of six weeks was fixed for the study. Another six weeks of follow up was also done after the active treatment was stopped. Patients were evaluated before starting the treatment (baseline) and then at an interval of every two weeks. All patients were thoroughly examined and their baseline BP (both systolic & diastolic) was recorded before starting any treatment. Then Laboratory investigations were done for every patient as per the protocol suggested by CCRAS for antihypertensive trials. All these information were maintained in a well designed research case sheet. This clinical study was conducted as per the Good Clinical Practice (GCP) guidelines and regulatory norms of India. The approval of the Institutional Ethical Committee (IEC) was obtained before starting the trial. Written informed consent was obtained from every patient as a prerequisite to be included in the trial.

Criteria for Inclusion & Exclusion

Both newly diagnosed and already diagnosed patients of EHTN of duration < 1 year without taking any antihypertensive medication for at least one month were selected for the study. We included patients of either sex in the age group of 35 – 60 years who had their Systolic Blood Pressure (SBP) ≥ 140 mmHg & < 160 mmHg with Diastolic blood pressure (DBP) ≥ 91 mmHg & < 100 mmHg.

Patients with hypertension due to any secondary cause, pregnant and lactating women, women planning pregnancy in next six months, patients with diabetes mellitus and patients with any complications like nephropathy, retinopathy, Chronic Kidney Disease (CKD), Congestive Cardiac failure (CCF), Left Ventricular Hypertrophy (LVH), Coronary Artery Disease (CAD) etc were excluded from the study.

Drug, Dosage & Duration

Punarnava (BD) capsules manufactured by Himalaya Drug Company, (Makali, Bangalore, India) were used as the trial drug (TD) and was administered to the patients in the Trial Group (Group – T). Each capsule contained 250 mg of *Punarnava* extract. It was given orally in a dose of 2 capsules twice in a day with water for six weeks.

Hydrochlorothiazide (HCTZ) tablets of strength 12.5 mg each, manufactured by Sun Pharmaceuticals were used as the standard control drug and was administered orally to the patients of control group (Group – C) in a dose of 1 tablet once in the morning with water for six weeks and a placebo was added in the evening to make the trial and control drug similar as far as possible.

Randomization

Patients were registered and examined on first come first served basis. They were randomized by generating two sets of random unique numbers in a randomization table with the help of standard computer software program.

Assessment Criteria

Clinical Parameters

In clinical assessment both Systolic & Diastolic Blood Pressure (SBP & DBP respectively) were taken as objective Parameters. The mean of SBP & the mean of DBP of three different readings at approximately the same timing on three consecutive days were taken as the baseline value before initiating any treatment. Subsequently the BP was recorded at the end of every two weeks till the completion of the study. But the same process as described above to record the baseline BP was applied to record the Blood Pressure at the end of treatment (i.e. end of 6th. week) and at the end of follow up without medication (i.e. end of 12th. week). The BP was recorded every time with the same ISI marked Sphygmomanometer to minimize instrumental error.

Headache, Dizziness and fatigue were considered as the subjective clinical parameters of assessment as the study included only mild (Stage – 1 as per JNC 7 classification) [1] cases of EHTN.

Headache Network Canada (HNC) Pain Scale (a self reporting tool to measure headache from 0 – 10) was used for headache.

Modified Borg rating scale for dizziness which measures dizziness from 0 – 10 was used for dizziness assessment.

Assessment of fatigue was done by Visual Fatigue Scale (VFS) designed by Oncology Nursing Society (ONS) which measures fatigue from 0 – 10.

Laboratory Investigations

Total Cholesterol, Serum Na^+, Serum K^+, Serum Urea, Serum Creatinine were done for every patient included in the trial at base line and at the end of the treatment (i.e. end of six weeks).

Reporting of Adverse Events

Adverse events if any with any of the patients either in trial or control group were recorded in every visit and they were compared with their baseline symptoms. Any reported adverse event was recorded carefully in the research case sheet.

Statistical Analysis

After assembling the different data in a master chart in Microsoft Excel Sheet they were analyzed for demographic information, any other information closely linked to the disease, efficacy of both trial and control

drug in subjective and objective parameters and safety profile of both the drugs. Frequency, Mean, Standard Deviation, Standard Error of Differences, Range were calculated to evaluate continuous variables. Count and percentage were used to evaluate categorical variables. Students Paired t - test was applied to test the significance. Data were presented in both tabular & graphical form. All statistical calculations were done by using Graph Pad software.

OBSERVATION & RESULTS

A total of 52 (27 from Trial Group & 25 from Control Group) subjects completed the study after 3 & 5 dropouts due to different reasons from Trial & Control groups respectively.

Important Demographic Observations

- Males (63 %) outnumbered Females (37 %) in the present study.
- The study included subjects in the age group of 30 - 60 but maximum subjects fall in the age group of 41 – 50 (50 %) & subjects in the age group of 31 – 40 were minimum (23 %).
- In alignment of the actual socio economic scenario of the locality, the sample was also dominated by subjects belonging to Lower Middle Class (as per Kuppuswamy's modified scale of Socio Economic Classification) [9] segment (48%).
- Hypertension was found to be well distributed across the subjects of different educational levels. However the subjects with only a school level education (below matriculation) were maximum (30 %) followed by Matriculates (27 %), Graduates (23 %), Post graduate (10 %), Intermediate (6 %) and Illiterate (4 %).
- The saliency of Service holders was maximum (33 %) followed by the saliency of house wives (21 %). Both these occupation involves aerobic physical inactivity which has a direct positive correlation with hypertension [10].

Observations Related to Risk Factors

- 31 % subjects of the sample were smokers & 33 % were chewing tobacco. This finding is in alignment of the fact that smoking is a strong independent risk factor for cardiovascular diseases including hypertension [11] as people who smoke show higher ambulatory blood pressure levels than non-smokers [12].
- 10 % subjects of the sample were alcohol abusers. Epidemiological data show a linear relationship between alcohol consumption and hypertension prevalence [12].
- The average salt (NaCl) intake per subject per day was approximately 15 gram which was 2.5 times the recommended quantity. There is a strong association between salt intake and elevated blood pressure [13].
- 52% of the total subjects were either overweight or obese. This must have increased their risk of developing hypertension as there is a direct association between blood pressure and body weight and/or abdominal adiposity [14].
- 19 % of the subjects gave a positive family history of hypertension or other cardiac events. Positive family history is a significant risk factor for hypertension [15].

RESULTS

Table : 1 Effectiveness of Trial & Control Drug on objective parameters

Parameter	Group	n	Before Treatment			After Treatment			↑ ↓	SED	D.F	t Value	p Value	Inference
			Mean	±	SD	Mean	±	SD						
Systolic BP (mm of Hg)	T	27	151.48	±	5.75	137.33	±	5.23	↓	0.98	26	14.38	< 0.0001	ES
	C	25	152.08	±	5.49	131.44	±	8.46	↓	1.66	24	12.40	< 0.0001	ES
Diastolic BP (mm of Hg)	T	27	95.41	±	2.06	87.11	±	4.75	↓	0.84	26	9.89	< 0.0001	ES
	C	25	95.36	±	1.89	85.68	±	5.44	↓	1.13	24	8.57	< 0.0001	ES
Total Cholesterol (mg/dl)	T	27	202.43	±	20.19	192.97	±	15.37	↓	1.38	26	6.85	< 0.0001	ES
	C	25	205.39	±	26.39	215.06	±	29.34	↑	3.95	24	2.45	0.0220	S
Serum Na+ (mmol/L)	T	27	144.9	±	4.62	140.02	±	4.98	↓	0.67	26	7.26	< 0.0001	ES
	C	25	145.07	±	4.73	137.1	±	4.75	↓	0.96	24	8.25	< 0.0001	ES
Serum K+ (mmol/L)	T	27	3.97	±	0.64	4.71	±	0.46	↑	0.09	26	7.46	< 0.0001	ES
	C	25	4.19	±	0.54	3.38	±	0.24	↓	0.11	24	7.10	< 0.0001	ES
Serum Urea (mg/dl)	T	27	27.75	±	5.97	22.99	±	3.07	↓	0.77	26	6.12	< 0.0001	ES
	C	25	29.65	±	6.43	39.04	±	4.33	↑	1.27	24	7.37	< 0.0001	ES
Serum Creatinine (mg/dl)	T	27	0.99	±	0.19	0.97	±	0.17	↓	0.02	26	1.32	0.1993	NS
	C	25	1.01	±	0.19	1.11	±	0.18	↑	0.03	24	3.13	0.0046	VS

T : Trial Group, C : Control Group, DF : Degree of Freedom, SED : Standard Error of Differences, SD : Standard Deviation, S: Significant, VS : Very Significant, ES : Extremely Significant & NS : Not Significant

Table : 2 Effectiveness of Trial & Control Drug on subjective parameters

Parameter	Group	n	Before Treatment Mean ± SD	After Treatment Mean ± SD	↑ ↓	SED	D.F	t Value	p Value	Inference
Headache	T	15	2.87 ± 1.06	0.53 ± 0.64	↓	0.21	14	11.06	< 0.0001	ES
	C	12	3 ± 0.95	2.17 ± 1.11	↓	0.32	11	2.59	0.0251	S
Dizziness	T	7	2.14 ± 1.07	0.29 ± 0.49	↓	0.44	6	4.18	0.0013	VS
	C	9	1.78 ± 1.79	2.22 ± 1.3	↑	0.58	8	0.77	0.4655	NS
Fatigue	T	10	3.1 ± 0.99	0.8 ± 0.63	↓	0.37	9	6.17	< 0.0001	ES
	C	17	3.5 ± 1.31	2.41 ± 1.28	↓	0.49	16	1.84	0.0936	NS

S: Significant, VS : Very Significant, ES : Extremely Significant & NS : Not Significant

Table : 3 Variation of Blood Pressure in Trial Group (TG) during Treatment and Post treatment phase

OBSERVATION OF BLOOD PRESSURE (TRIAL GROUP)	SBP MEAN ± SD	DBP MEAN ± SD
Before Treatment (BT)	151.48 ± 5.75	95.41 ± 2.06
After Treatment (AT @ End of Week 2)	144.07 ± 6.98	91.48 ± 2.64
After Treatment (AT @ End of Week 4)	140.15 ± 5.84	88.67 ± 3.96
After Treatment (AT @ End of Week 6)	137.33 ± 5.23	87.11 ± 4.75
1st Follow up after stopping the Control Drug (End of Week 8)	141.11 ± 6.23	90.96 ± 4.38
2nd Follow up after stopping the Control Drug (End of Week 10)	145.78 ± 6.01	93.11 ± 3.94
3rd Follow up after stopping the Control Drug (End of Week 12)	150.96 ± 5.61	95.33 ± 3.64

Chart : 1 Variation of Blood Pressure in Trial Group (TG) during Treatment and Post treatment phase

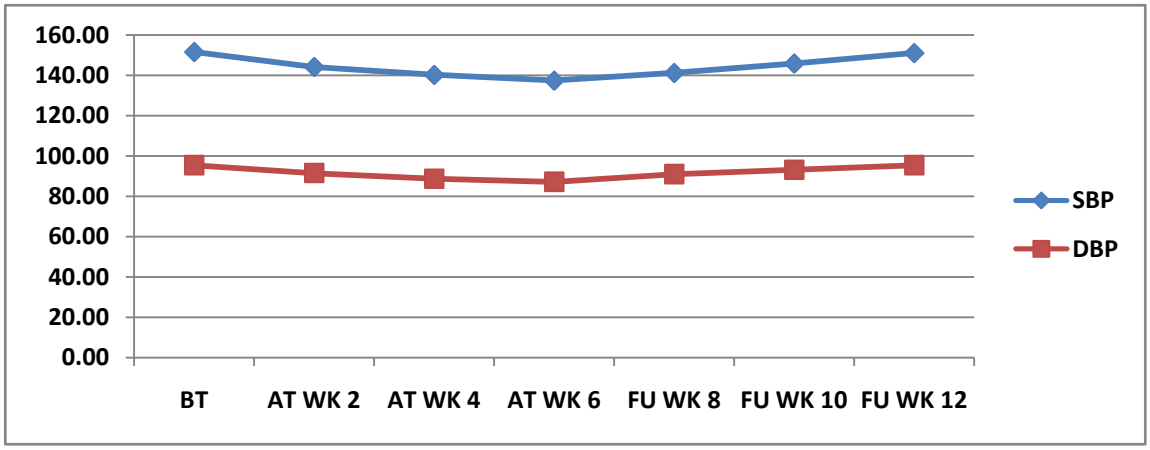

Table : 4 Variation of Blood Pressure in Control Group (CG) during Treatment and Post treatment follow up phase

OBSERVATION OF BLOOD PRESSURE (CONTROL GROUP)	SBP			DBP		
	MEAN	±	SD	MEAN	±	SD
Before Treatment (BT)	152.08	±	5.49	95.36	±	1.89
After Treatment (AT @ End of Week 2)	143.36	±	6.82	91.68	±	2.63
After Treatment (AT @ End of Week 4)	139.6	±	5.94	88.32	±	4.07
After Treatment (AT @ End of Week 6)	131.44	±	8.46	85.68	±	5.44
1st Follow up after stopping the Control Drug (End of Week 8)	140.64	±	6.18	90.64	±	4.39
2nd Follow up after stopping the Control Drug (End of Week 10)	145.84	±	6.08	93.04	±	4
3rd Follow up after stopping the Control Drug (End of Week 12)	150.08	±	5.7	94.64	±	3.09

Chart : 2 Variation of Blood Pressure in Control Group (CG) during Treatment and Post treatment follow up phase

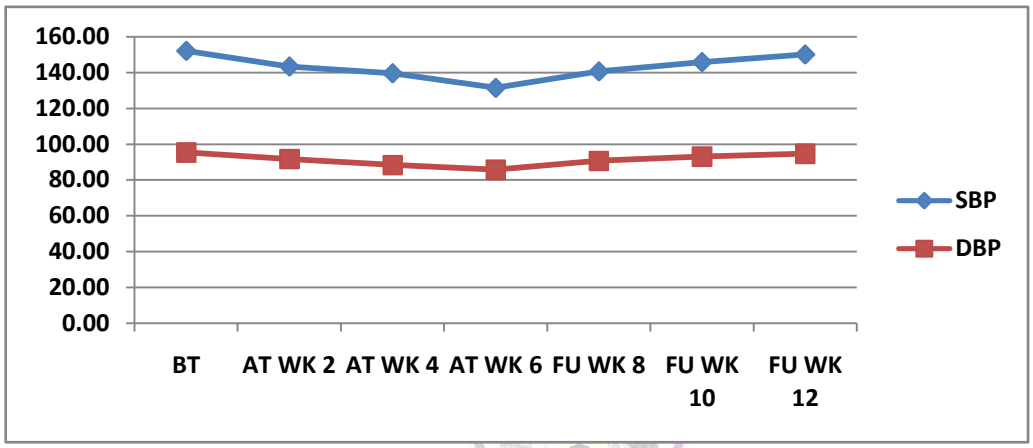

Table : 4 Incidence of Adverse effects in Trial & Control Group

Sl. No	Type of Complain	No of Patients Reporting this complain			
		Trial Group	Percentage (%)	Control Group	Percentage (%)
1	Muscle Pain	Nil	Nil	5	20
2	Stomach Pain	1	3	3	12
3	Blurred Vision	Nil	Nil	1	4
4	Skin Rashes	Nil	Nil	Nil	Nil
5	Orthostatic Hypotension	1	3	4	16
6	Hair Fall	Nil	Nil	Nil	Nil
7	Anorexia	Nil	Nil	3	12
8	Diarrhoea	Nil	Nil	Nil	Nil
9	Constipation	1	3	3	12
10	Dry Mouth	Nil	Nil	1	4
11	Excess Thirst	Nil	Nil	2	8
12	Nausea	Nil	Nil	1	4

Both the Trial and Control group have shown statistically significant reduction of systolic and diastolic blood pressure. But the control drug has shown better results than trial drug.

In Trial Group (TG) the mean Systolic BP before treatment was 151.48 ± 5.75. It came down to 137.33 ± 5.23 after 6 weeks of treatment which was extremely significant. On the other hand the mean Diastolic BP before treatment was 95.41 ± 2.06 which came down to 87.11 ± 4.75 after 6 weeks of treatment which was also found to be extremely significant.

In Control Group (CG) the mean Systolic BP before treatment was 152.08 ± 5.49. It came down to 131.44 ± 8.46 after 6 weeks of treatment. The mean Diastolic BP before treatment was 95.36 ± 2.06 which came down to 85.68 ± 5.44 after 6 weeks of treatment. Both the changes were statistically found to be extremely significant.

All the patients in both the Trial & Control Group were followed up for a similar six weeks period after stopping the Trial & Control Drug respectively. During these six weeks follow up phase after the completion of six weeks treatment most of the patients in both trial & control group showed a gradual raise in both systolic and diastolic BP. At the end of Six weeks follow up after treatment phase the individual SBP & DBP of both Trial & Control Group reached almost to their respective baseline values before treatment.

The Total Cholesterol decreased from 202.43 ± 20.19 to 192.97 ± 15.37 mg/dl in trial group where as it increased from 205.39 ± 26.39 to 215.06 ± 29.34 mg/dl in control group. The changes were extremely significant & significant in TG & CG respectively.

Serum Sodium (Na+) level decreased significantly in both groups. It decreased from 144.90 ± 4.62 to 140.02 ±4.98 mmol/L & from 145.07 ± 4.73 to 137.10 ± 4.75 mmol/L in trial & control groups respectively.

Serum Potassium (K +) level increased from 3.97 ± 0.64 to 4.71 ± 0.46 mmol/L in trial group where as it decreased from 4.19 ± 0.54 to 3.38 ± 0.24 mmol/L in control group. Statistically both the changes were found to be extremely significant.

Serum urea level decreased from 27.75 ± 5.97 to 22.99 ± 3.07 mg/dl in trial group where as it increased from 29.65 ± 6.43 to 39.04 ± 4.33 mg/dl in control group. Both the changes were statistically found to be extremely significant.

Serum creatinine level decreased insignificantly in trial group from 0.99 ± 0.19 to 0.97 ± 0.17 mg/dl. But it increased from 1.01 ± 0.19 to 1.11 ± 0.18 mg/dl in control group which was statistically found to be very significant.

Headache was reduced in both trial & control group. It significantly reduced from 2.87 ± 1.06 to 0.53 ± 0.64 in trial group. But it significantly reduced from 3.00 ± 0.95 to 2.17 ± 1.11 in control group.

Dizziness was reduced very significantly from 2.14 ± 1.07 to 0.29 ± 0.49 in trial group. But it increased in control group from 1.78 ± 1.79 to 2.22 ± 1.30; however this increase in dizziness was statistically not significant.

Fatigue was reduced in both trial & control group. It reduced from 3.10 ± 0.99 to 0.80 ± 0.63 in trial group & from 3.50 ± 1.31 to 2.41 ± 1.28 in control group. The change was statistically extremely significant in trial group but not significant in control group.

The effectiveness of the control drug was better in reducing both SBP & DBP but effectiveness of the trial drug was much better in subjective parameters like headache, dizziness & fatigue.

Adverse effects like stomach pain, muscle pain, constipation, blurring of vision, orthostatic hypotension etc were reported more in control group. There was almost no adverse effect reported in the trial group for the trial drug except one case each from constipation, stomach pain & orthostatic hypotension.

DISCUSSION

The antihypertensive activity of the trial drug *Punarnava* may be attributed to its Pharmacological properties shown by the active ingredients. *Punarnava* contains active principles like Liridodendrin & Hypoxanthine which are active antihypertensive agents and the former is Ca+2 channel antagonist. It acts as diuretic by increasing renal blood flow [16]. It can relax the smooth muscles of the arterial wall. This effect seems to be due to the presence of boeravinones and the involvement of extracellular calcium and/or L-type calcium channels. Further, the methanolic root extract of *B. diffusa* also exerts antioxidant and genoprotective activity in both chemical and cell based assays. Boeravinone G, H and D appear to be the responsible active principles for the antioxidant activity, with boeravinone G playing a major role.[17] Ayurveda also describes *Punarnava* to be *Rasayana*. Therefore it can help delaying the aging process of arterial wall & prevent arteriosclerosis. It also possesses antihyperlipidemic property which helps in improving BP control. *Punarnava* contains Potassium Nitrate (KNO3).Being a good source of Potassium (K) it increases serum K+ and reduces serum Na+ levels which also facilitates BP reduction in HTN. [18]

So either of the properties like Calcium channel blocking, vasodilating, antihyperlipidemic, serum K+ increasing, serum Na + reducing, diuretic & antioxidant might be involved singly or in synergistic combination to produce the antihypertensive effect of *Punarnava.*

The clinical efficacy of both BD & HCTZ were almost comparable in reduction of Essential Hypertension where as the safety profile of BD was much better as it did not show adverse effects like hyperaemia, hypercholesterolemia and hypokalemia in contrast to HCTZ.

CONCLUSION

In the present study, *Punarnava (Boerhaavia diffusa)* shown promising results in mild cases of essential hypertension. It significantly reduced both SBP & DBP in most of the subjects. The results were comparable to that of the control drug (Hydrochlorothiazide). It also extremely significantly reduced other symptoms of EHTN like headache, dizziness & fatigue which were also much better as compared to the control drug. But our sample size was not too big to conclude that *Punarnava* can be confidently given as a single drug in all of the cases of mild EHTN.

More importantly the trial drug *Punarnava* was well tolerated, absolutely safe and free from adverse effects unlike the control drug. Therefore it can be used continuously for a long duration without any side effects. This fulfils an important criterion to be a successful antihypertensive drug.

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