

# Comparative Study of Clinical Efficacy and Adverse Drug Reactions Produced by Enalapril and Ramipril in Patients of Moderate Hypertension

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## Research Article

**Abstract: Introduction:** Hypertension is one of the leading causes of global burden of disease. Approximately 7.6 million deaths [13-15% of total deaths] and 92 million disability-adjusted life years worldwide were attributable to high blood pressure in 2001. Angiotensin converting enzyme inhibitors (ACEIs) have a well-established role in the management of essential hypertension. This study was prompted by the fact that a large number of people suffer from essential hypertension and ACEIs certainly are among the most widely prescribed agents in its treatment. It is therefore imperative that we should have maximum data on their pattern of utilization and the adverse drug reactions. **Aims and Objective-** To observe and compare the anti-hypertensive efficacy as well as incidence of adverse drug reactions between enalapril and ramipril. **Materials and Methods-** This prospective, comparative, open-label study included 80 patients suffering from stage I / II essential hypertension. These patients included males and females randomized in each study Group. **Observation and Result:** In the present study, we observed that enalapril, ramipril are effective agents in reducing both systolic and diastolic BP throughout the study period when measured at the 15<sup>th</sup> day, 30<sup>th</sup> day, 45<sup>th</sup> day and 90<sup>th</sup> day. When efficacy was compared, we found that these two drugs were equally effective in reducing the systolic and diastolic blood pressure. A total of 25% of the patients reported some sort of adverse-effects like cough (10%), nausea (7.5%), musculoskeletal pain (2.5%), headache (5%) and dizziness (0%) in the enalapril treated Group A and 22.5% in the ramipril treated Group B, with noted adverse-effects like cough (10%), headache (5%), dizziness (2.5%), nausea (5%) and musculoskeletal pain (0%). **Conclusion-** The antihypertensive effect of these two drugs included in the study was statistically significant. These two drugs were equally effective in reducing the systolic and diastolic blood pressure. The incidence of nausea and musculoskeletal pain was more in enalapril treated group than ramipril group and incidence of dizziness was more in ramipril group than enalapril Group. However, this difference in the frequency of overall adverse-effects between the two groups was not statistically significant ( $P > 0.05$ ). Adverse effects were tolerated by both the study Groups and hence effective antihypertensive drugs in management of essential hypertension.

**Key words:** ACE-inhibitors, enalapril, hypertension, ramipril.

## Introduction

Hypertension is one of the leading causes of global burden of disease. Approximately 7.6 million deaths [13-

15% of total deaths] and 92 million disability-adjusted life years worldwide were attributable to high blood pressure in 2001. Hypertension doubles the risk of cardiovascular diseases, including Congenital Heart diseases, congestive heart failure, ischemic and hemorrhagic stroke, renal failure and peripheral arterial disease. It is often associated with additional cardiovascular disease risk factors and the risk of cardiovascular disease increase with the total burden of risk factors. Hypertension is a "life time" condition and, if left untreated, leads to lethal complications. The renin-angiotensin system plays an important role in the regulation of normal blood pressure (BP) and also in the pathogenesis and maintenance of essential hypertension. Angiotensin II acts on AT1 Receptors and causes vasoconstriction, 40 times more than Noradrenaline and also secretes Aldosterone leading to Na<sup>+</sup> and H<sub>2</sub>O retention which ultimately causes rise in blood pressure.<sup>[1]</sup> Angiotensin converting enzyme inhibitors (ACEIs) have a well-established role in the management of essential hypertension. They are structurally classified as sulfhydryl containing ACEIs, for example, captopril, fentiapril, zofenopril, and so on; di-carboxyl containing ACEIs namely enalapril, lisinopril, perindopril, quinopril, moexipril, and so on; and phosphonate containing ACEIs namely fosinopril, on the basis of their binding with the angiotensin converting enzyme (ACE).<sup>[2]</sup> This study was prompted by the fact that a large number of people suffer from essential hypertension and ACEIs certainly are among the most widely prescribed agents in its treatment. It is therefore imperative that we should have maximum data on their pattern of utilization and the adverse drug reactions. The purpose of the present study was to observe the anti-hypertensive efficacy and incidence of adverse drug reactions between the di-carboxyl Group containing ACE inhibitors namely enalapril and ramipril.

## Aims and Objectives

- To study and compare the efficacy of enalapril and ramipril in patients of stage I/II essential hypertension.
- To study and compare various adverse effects caused by enalapril and ramipril, in patients of stage I/II essential hypertension.

## Materials and Methods

Eighty patients ( male, female) suffering from stage I / II essential hypertension, according to JNC-VII guidelines,<sup>[3]</sup> without any underlying comorbid conditions or complications, aged between 20 and 60 years, were enrolled in the study after obtaining informed consent and due approval of the ethics committee.

**Study design:** It was a prospective, parallel, open-label, comparative trial, and the patients were randomised into two Groups of 40 each.

- Group A-Includes subjects receiving enalapril
  - Group B-Includes subjects receiving ramipril
- Each Group received enalapril (5mg) and ramipril (2.5 mg), respectively once daily. The investigational drugs were prescribed by the Cardiologist to the study subjects and purchased from the hospital pharmacy. The individual dose was subsequently titrated in case of inadequate blood pressure control, which was predefined for blood pressure levels of < 140 / 90 mmHg.

## Method

Standardized technique was used to measure blood pressure. Mercury sphygmomanometer was used for measuring blood pressure.

The Blood pressure was ideally taken in the sitting position with the back supported. Supine values tend to be slightly different with the systolic pressure higher by 2 to 3mmHg and the diastolic pressure lowered by a similar margin. The arm was kept resting comfortably at heart level.

- Cuff containing the correct sized bladder was wrapped smoothly, snugly and evenly around the arm with the middle of the balloon over the brachial artery
- Brachial or radial pulse was palpated.
- The cuff is inflated and by palpation the approximate systolic pressure is taken, identifying the point when the pulse is obliterated. Deflate the cuff and then reinflate to 20 mm above this value. This overcomes the problem of the auscultatory or "silent gap" where sounds may disappear for a while and the true systolic value may be missed.
- The pressure is slowly and steadily (2-3 mm per second) reduced, listening with the bell of the stethoscope over the brachial artery for Korotkoff sounds:

- 1st Phase or Korotkoff 1 - First appearance of faint, tapping sounds, gradually increasing in intensity. This corresponds to the systolic pressure.
- The point at which sounds disappear. This corresponds to the diastolic pressure.

On confirming the diagnosis, the baseline blood pressure in the left arm (sitting position) was recorded after allowing 10 minutes of rest for each subject.

Every subject was followed up for four months, which included eight follow-ups at an interval of 15 days. During every follow-up, the blood pressure in the left arm (sitting position) was recorded after allowing 10 minutes of rest, the compliance with therapy and use of concomitant medicines was documented;

## Inclusion criteria

- 1) Patients with Moderate Hypertension without complications
- 2) Patients with age Group between 20-60 years
- 3) Equal male and females

## Exclusion criteria

- 1) Patients with Cardiovascular abnormalities like Myocardial Infarction, Angina Pectoris.
- 2) Patients with Bronchial Asthma.
- 3) Patients with Renal Failure.
- 4) Patients with Cerebrovascular accidents.
- 5) Any additional anti-hypertensive medication precluded the subject from continuing in the study.

Hematological and biochemical examinations were performed at baseline and end of the study.

Haematological and biochemical examinations included

- Complete blood picture
- Serum creatine
- Serum electrolytes
- Plasma lipid profile
- Blood sugars

Other investigations included

- Chest X-ray
- Electrocardiogram

Complete history of the patients was documented, regarding their lifestyle, diet, family etc.

Height and weight of the patients were documented to calculate the Body mass index and grade and relate the physical status of them. Adverse Events (AEs) if any were documented during the follow-up visit and their causality was assessed using the Naranjo ADR probability scale<sup>[4]</sup>. For grading adverse drug reactions, such as, dizziness, musculoskeletal pain, fatigue, cough, headache, and nausea, a visual rating scale (VRS) was employed; Cough was further evaluated on the basis of its interference in routine activities and sleep disturbances in

the subject. To propose a hypothesis, after comparing the incidence of ADRs between the two drugs, namely enalapril and ramipril, we employed the statistical hypothesis test of Student's t-test and ANOVA, to calculate the P-value in terms of significance. GraphpadInstat® ver. 3.10, 32 bit for Windows was used for statistical analyses. Student's t-test was used to compare the blood pressures between 0 day, 15<sup>th</sup>, 30<sup>th</sup>, 45<sup>th</sup> and 90<sup>th</sup> day of Group A and Group B. This comparison was done for each Group and for each parameter (SBP, DBP) separately. ANOVA was used to compare the antihypertensive efficacy between the Groups.

## Results

The prospective, comparative, open-label study included 80 patients suffering from stage I/II essential hypertension. These included males and females randomized in each study Group. It was evident that the number of males in each study Group was more than the females. Their mean ( $\pm$  S.D.) age was 48.816( $\pm$ 7.17955) years; baseline blood pressure (systolic / diastolic) mm Hg was 168.65( $\pm$ 1.2549)/104.5( $\pm$ 5.97) mm Hg for ramipril Group, 164.5( $\pm$ 8.149) mm Hg for enalapril Group and body mass index 27.6 kg/m<sup>2</sup>. The target blood pressure of  $\leq$  140/ 90 mm Hg was achieved in all subjects by appropriate individualized dose titration. The mean ( $\pm$ SD) blood pressure at end of the study was observed as 122.5( $\pm$ 6.69)/80.15( $\pm$ 1.05), mm Hg, 121.25 ( $\pm$ 6.07)/80.15( $\pm$ 1.05)mm Hg, in Group A, Group B respectively. The study drugs were tolerated by the majority. It is evident that a majority (45%) of the subjects were in the age range of 41-50 years, whereas, only 25% of the population was in the age Group of 51-60 years. During the study, three patients discontinued and it was compensated by inclusion of newly diagnosed patients basing on the inclusion and exclusion criteria. Baseline clinical characteristics of patients receiving enalapril and ramipril were compared. The Groups were similar and comparable as regards systolic blood pressure, diastolic blood pressure and heart rate before treatment. There were no significant ECG changes in the study subjects before and during the study.

### In The Enalapril-Treated- Group A

The mean systolic blood pressure prior to treatment was 164.5mmHg. After treatment, the systolic BP reduced to 136.75 mmHg, 134.25, 120.5 mmHg and 122.5mmHg at

15<sup>th</sup> day, 30<sup>th</sup> day, 45<sup>th</sup> day and 90<sup>th</sup> day respectively. The reduction in systolic BP was found to be statistically significant ( $P < 0.001$ ) at 15<sup>th</sup> day, 30<sup>th</sup> day, 45<sup>th</sup> day and 90<sup>th</sup> day of therapy when compared with the baseline readings. The mean diastolic BP before enalapril treatment was 106.25mmHg. After treatment, the diastolic BP reduced to 85.25mmHg, 83.75mmHg, 80 mmHg and 80 mmHg at 15<sup>th</sup> day, 30<sup>th</sup> day, 45<sup>th</sup> day and 90<sup>th</sup> day respectively. The reduction in diastolic BP was found to be statistically significant ( $P < 0.001$ ) at 15<sup>th</sup> day, 30<sup>th</sup> day, 45<sup>th</sup> day and 90<sup>th</sup> day of therapy when compared with the baseline readings.

### In The Ramipril-Treated- Group B

The mean systolic BP prior to treatment was 168.67mmHg. After treatment, the systolic BP reduced to 138.25 mmHg, 133.82mmHg, 119.6mmHg and 121.15mmHg at 15<sup>th</sup> day, 30<sup>th</sup> day, 45<sup>th</sup> day and 90<sup>th</sup> day respectively. The reduction in systolic BP was found to be statistically significant ( $P < 0.001$ ) at 15<sup>th</sup> day, 30<sup>th</sup> day, 45<sup>th</sup> day and 90<sup>th</sup> day of therapy when compared with the baseline readings. The mean diastolic BP before ramipril treatment was 102mmHg. After treatment, the diastolic BP reduced to 85.5mmHg, 80mmHg, 84.5mmHg and 79.75mmHg at 15<sup>th</sup> day, 30<sup>th</sup> day, 45<sup>th</sup> day and 90<sup>th</sup> day respectively. The reduction in diastolic BP was found to be statistically significant ( $P < 0.001$ ) at 15<sup>th</sup> day, 30<sup>th</sup> day, 45<sup>th</sup> day and 90<sup>th</sup> day of therapy when compared with the baseline readings.

### InterGroup comparison was done considering Group A as standard Group

Taking enalapril treated Group A as standard Group, interGroup comparison was done. The 90<sup>th</sup> day blood pressures were compared between the Groups. The mean systolic blood pressure on 90<sup>th</sup> day of enalapril treated Group A was 122.5mm Hg and mean diastolic blood pressure was 80mm Hg. The mean systolic blood pressure on 90<sup>th</sup> day of ramipril treated Group B was 121.15mm Hg and mean diastolic blood pressure was 79.75mm Hg. The interGroup comparison was done using student's t-Test –Two sample and Analysis of variance. Comparison of Group A 90<sup>th</sup> day blood pressures [SBP/DBP] with Group B 90<sup>th</sup> day blood pressures [SBP/DBP] using t-Test, the p-value was  $P > 0.05$  which is insignificant. Using analysis of variance the two Groups were compared column wise and the resultant p-value was  $P > 0.05$  which is insignificant.

**Table1:** Effects of the study drugs: Group A Enalapril, Group B Ramipril on systolic blood pressure (mm Hg):intra-Group analysis

Treatment Groups		At different time points			P-value	Test used
		Baseline	15 <sup>TH</sup> DAY	90 <sup>TH</sup> DAY		
Group A	mean	164.5	136.75	122.5	***P < 0.0001	Paired t-Test
	SD	8.14	4.740	6.69		
Group B	mean	168.67	138.25	121.15	*** P< 0.0001	Paired t-Test

	SD	7.93	3.84	5.14		
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SD- standard deviation, \*\*\* extremely significant, \*\* very significant, \* significant, NS- not significant

**Table 2 :** Effects of the study drugs: Group A Enalapril, Group B Ramipril on systolic blood pressure (mm Hg): interGroup analysis

Time Points	Treatment Groups			Test used
	GROUP A [MEAN] MM HG	GROUP B [MEAN] MM HG	P-value	
Baseline	164.5	168.75	NS P>0.05	t- Test
15 <sup>TH</sup> Day	136.75	138.25	NS P>0.05	t- Test
30 <sup>TH</sup> Day	134.25	133.8	NS P>0.05	t- Test
45 <sup>TH</sup> Day	120.5	119.62	NS P>0.05	t- Test
90 <sup>TH</sup> Day	122.5	121.15	NS P>0.05	t- Test

\*\*\*extremely significant, \*\*very significant, \*significant, NS-not significant

**Table 3:** Effects of the study drugs: Group A Enalapril Group B Ramipril on diastolic blood pressure (mm Hg): intra-Group analysis

		At different time points			P-value	Test used
Treatment Groups		Baseline	15 <sup>TH</sup> DAY	90 <sup>TH</sup> DAY		
Group A	mean	106.25	85.25	80.15	***P < 0.0001	PAIRED t-TEST
	SD	4.9	5.05	1.05		
Group B	mean	104.5	85.5	79.75	*** P< 0.0001	PAIRED t-TEST
	SD	5.97	5.03	1.58		

SD- standard deviation, \*\*\* extremely significant, \*\* very significant, \* significant, NS- not significant

**Table 4:** Effects of the study drugs: Group A Enalapril, Group B Ramipril on diastolic blood pressure (mm Hg): interGroup analysis

Time Points	Treatment Groups			Test used
	GROUP A [mean] mm HG	GROUP B [mean] mm HG	P-value	
Baseline	106.25	104.5	ns P>0.05	t- TEST
15 <sup>TH</sup> DAY	85.25	85.5	ns P>0.05	t- TEST
30 <sup>TH</sup> DAY	83.75	80.15	ns P>0.05	t- TEST
45 <sup>TH</sup> DAY	80.15	80.45	ns P>0.05	t- TEST
90 <sup>TH</sup> DAY	80.15	79.75	ns P>0.05	t- TEST

\*\*\*extremely significant, \*\*very significant, \*significant, NS-not significant

### Adverse drug reactions

The safety analysis was performed on all patients who completed the study. The various adverse drug reactions observed in the study subjects were dizziness, cough, musculoskeletal pain, fatigue, headache, nausea [Table 5]. A total of 25% of the patients reported some sort of adverse-effects like cough (10%), nausea (7.5%), musculoskeletal pain (2.5%), headache (5%) and dizziness (0%) in the Group A and 22.5% in the ramipril treated Group B, with noted adverse-effects like cough (10%), headache (5%), dizziness (2.5%), nausea (5%) and musculoskeletal pain (0%). However, this difference in the overall frequency of adverse-effects between the Groups was not statistically significant ( $P > 0.05$ ).

**Table 5:** Summary of Incidence of All Adverse Drug Reactions Observed in the Study Subjects (N = 120)

Adverse Drug Reaction Observed	Enalapril [n=40]	Ramipril [n=40]
Cough	4	4
Nausea	3	2
Headache	2	2
Musculoskeletal pain	1	0
Dizziness	0	1

### Cough

Four subjects on enalapril (10%; 95%CI) and four subjects on ramipril (10%; 95% CI). Details regarding the intensity of the cough and other related features are tabulated in [Table 6]. Cough was seen in both male and female of two Groups. For ramipril treated Group B both male and female were equally affected, whereas in enalapril treated Group A male were more affected than female. Cough was seen in all the age Groups. Subjects receiving enalapril and ramipril developed dry cough after one to one and half month of therapy. In all these subjects, the cough was mild in nature and there were no specific aggravating or relieving factors. It did not warrant discontinuation of therapy.

### Nausea

3 subjects on enalapril (7.5% incidence; 95% C.I.) and two subjects on ramipril (5%; 95% C.I.), presented with nausea. The nausea was mild-to-moderate in intensity. The time of onset was 60-90 minutes after consuming the drug and it lasted for another two to three hours in all the subjects. There were no associated episodes of vomiting. Nausea did not warrant discontinuation of therapy. Musculoskeletal pain was seen in younger age Groups between 30-40 years.

**Table 6:** Cough Seen in Study Subjects of Group A, Group B (N=8)

Characteristic Features of Cough	Ramipril	Enalapril
No. of Cases	4	4
Sex Distribution	2M+2F	3M+1F
Onset	1 Month	1 Month
Nature	Mild	Mild
Discontinuation from Therapy	No	No
Sleep Disturbances	No	No

**Table 7:** Nausea Observed in Study Subjects of Group A, Group B (N=5)

Characteristic Features of Cough	Ramipril	Enalapril
No. of Cases	2	3
Sex Distribution	1M+1F	2M+1F
Intensity	Mild	Mild
Time of Onset	1 Hour	1 Hour
Duration	2-5	2-5

## Discussion

1. The ability to reduce levels of angiotensin II with orally effective inhibitors of angiotensin converting enzyme represents an important advance in the treatment of hypertension. Captopril, enalapril, lisinopril, quinapril, ramipril, benazepril, fosinopril, trandolapril and perindopril have proven to be very useful for the treatment of hypertension because of their efficacy and their very favorable profile of adverse effects<sup>[1]</sup>, which enhances patient adherence.
2. The ACE inhibitors appear to confer a special advantage in the treatment of patients with diabetes mellitus, slowing the development and progression of diabetic glomerulopathy. They also are effective in slowing the progression of other forms of chronic renal disease, such as glomerulosclerosis in patients of hypertension. ACE inhibitors are the preferred initial agent in these patients. Patients with hypertension and ischemic heart disease are candidates for treatment with ACE inhibitors because administration of ACE inhibitors in the immediate post-myocardial infarction period has been shown to improve ventricular function and reduce morbidity and mortality. The decreased biosynthesis of AngiotensinII, impacts a number of facets of hypertension treatment. Because ACE inhibitors blunt the rise in aldosterone concentrations in response to Na<sup>+</sup> loss, the normal role of aldosterone to oppose diuretic-induced natriuresis is diminished.<sup>[5]</sup>
3. Our study was designed to monitor the efficacy and various adverse drug reactions seen with the ACEIs containing the di-carboxyl Group namely enalapril and ramipril, with the aim to observe the efficacy and

incidence of adverse drug reactions between these two Groups.

4. In the present study, we have observed that Enalapril, Ramipril are effective agents in reducing both systolic and diastolic BP throughout the study period when measured at the 15<sup>th</sup> day, 30<sup>th</sup> day, 45<sup>th</sup> day and 90<sup>th</sup> day. When efficacy was compared, we found that these two drugs were equally effective in reducing the systolic and diastolic blood pressure.
5. The mean ( $\pm$  S.D.) age was 48.816 ( $\pm$  7.17955) years.
6. Baseline blood pressure (systolic / diastolic) mm Hg was 168.65 ( $\pm$  1.2549) / 104.5 ( $\pm$  5.97) mm Hg for ramipril Group, 164.5 ( $\pm$  8.149) / 106.25 mm Hg for enalapril Group and body mass index 27.6 kg/m<sup>2</sup>. The target blood pressure of  $\leq$  140/90 mmHg was achieved in all subjects by appropriate individualized dose titration.
7. The mean ( $\pm$ SD) blood pressure at end of the study was observed as 122.5 ( $\pm$  6.69) / 80.15 ( $\pm$  1.05) mmHg, 121.15 ( $\pm$  5.14) / 79.75 ( $\pm$  1.58) mmHg in Group A, Group B respectively.
8. There were no significant ECG changes in the study subjects before and during the study.
9. In our study, the incidence of cough with ramipril (10%; 95% CI) and enalapril (10%; 95%CI) was similar to that reported in literature. Subjects receiving enalapril and ramipril developed dry cough after one to one and half month of therapy. In all these subjects, the cough was mild in nature and there were no specific aggravating or relieving factors. It did not warrant discontinuation of therapy.
10. In literature- dry, brassy cough is commonly reported with the use of ACEIs and is estimated to be in the range of 5-10%.<sup>[6],[7],[8],[9]</sup> The cough is usually persistent, paroxysmal, non-productive, worsening in the lying down position, and at times accompanied by a change in voice.<sup>[10]</sup> Studies have suggested the involvement of mediators such as, bradykinin, prostaglandins or substance P as mediators of the cough.<sup>[11],[12]</sup> A literature survey suggests about a 6% incidence of cough with enalapril and ramipril.<sup>[6],[7],[8]</sup> Some studies have suggested about 12% incidence of cough with enalapril<sup>[14]</sup>.
11. Our findings indicated that the incidence of nausea was higher (7.5%) with enalapril, when compared to ramipril (5%). A literature survey suggests nausea with use of ACEIs is around 1-5%.<sup>[11], [13]</sup> Some studies have suggested, incidence of nausea as 5-10% with enalapril, 10% with ramipril.<sup>[14], [15]</sup> The causality needs to be confirmed by evaluating a larger number of subjects to make the study representative of the Indian population.

12. Our findings indicated that the incidence of musculoskeletal pain was enalapril (2.5%), when compared to ramipril (0%). In another study, it was 3.3% with enalapril and ramipril.<sup>[15]</sup>
13. The incidence of dizziness in this study was enalapril (0%), ramipril (2.5%). In other comparative studies it was 6.6% with enalapril and 3.3% with ramipril.<sup>[14],[15]</sup>
14. The incidence of headache in this study was enalapril (5%), ramipril (5%). In other comparative studies it was 6.6% with enalapril and 3.3% with ramipril.<sup>[14],[15]</sup>
15. The changes in laboratory parameters were minor and of no clinical relevance. As in previous studies change in plasma glucose and lipid values was slight with ACE inhibitors.<sup>[15]</sup>
16. In consideration of cost, enalapril is the cheapest antihypertensive drug available in the market which is also well tolerated by the patients when compared to the other ACE inhibitors. Approximate cost of enalapril and ramipril is Rs/- 2.85 and Rs/- 11.35 respectively.

## Summary and Conclusion

1. In the present study, the efficacy and incidence of adverse drug reactions between enalapril and ramipril in patients suffering from essential hypertension [Stage I/II] was studied.
2. Eighty newly diagnosed patients (male, female) suffering from stage I / II essential hypertension, according to JNC-VII guidelines, without any underlying comorbid conditions or complications, aged between 20 and 50 years, were enrolled in the study.
3. The number of males in each study Group was more than the females. The mean ( $\pm$ S.D.) age was 48.816( $\pm$ 7.17955) years in the study subjects.
4. Baseline blood pressure (systolic/ diastolic) mm Hg was 168.65( $\pm$ 1.2549)/104.5( $\pm$ 5.97) mmHg for ramipril Group, 164.5( $\pm$ 8.149)/106.25 mm Hg for enalapril Group and body mass index 27.6 kg/m<sup>2</sup>. The target blood pressure of  $\leq$  140/ 90 mm Hg was achieved in all subjects by appropriate individualized dose titration.
5. The mean ( $\pm$ SD) blood pressure at end of the study was observed as 122.5( $\pm$ 6.69)/80.15( $\pm$ 1.05) mmHg, 121.15( $\pm$ 5.14)/79.75( $\pm$ 1.58) in Group A, Group B respectively.
6. The various adverse drug reactions observed in the study subjects were dizziness, cough, musculoskeletal pain, fatigue, headache, nausea.
7. A total of 25% of the patients reported some sort of adverse-effects like cough (10%), nausea

(7.5%), musculoskeletal pain (2.5%), headache (5%) and dizziness (0%) in the Group A.

8. A total of 22.5% in the ramipril treated Group B, with noted adverse-effects like cough (10%), headache (5%), dizziness (2.5%), nausea (5%) and musculoskeletal pain (0%).
9. The incidence of nausea was higher (7.5%) with enalapril, when compared to ramipril (5%). A literature survey suggests nausea with use of ACEIs is around 1-5%.<sup>[11],[13]</sup> Some studies have suggested, incidence of nausea as 5-10% with enalapril, 10% with ramipril.<sup>[14],[15]</sup> The causality needs to be confirmed by evaluating a larger number of subjects to make the study representative of the Indian population.

The antihypertensive effect of these two drugs included in the study was statistically significant. Though it had adverse effects, they were tolerated by majority of the study Groups and hence enalapril and ramipril are effective antihypertensive drugs in management of essential hypertension.

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