

Original Article

Early evidence for inclusion of practice of morning ingestion of water as a lifestyle modification (adjuvant) in management of hypertension in patients of diabetes mellitus

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ABSTRACT

Objectives: Researches reflecting the role of water in blood pressure (BP) regulation are documented to a lesser degree. A holistic approach, combining standard treatment protocols with lifestyle modifications, serves as the best approach to check the increasing prevalence and coexistence of hypertension (HTN) and diabetes mellitus. Thus, we aim to assess the effects of morning ingestion of water on HTN in diabetic individuals when practiced adjuvant with antihypertensive and oral hypoglycemic medications.

Materials and Methods: We conducted a prospective cohort with 68 patients having diabetes mellitus and HTN, with 34 participants each in the study and control group. The control group followed standard treatment protocol for HTN and diabetes mellitus. Study group in adjuvant to above practiced drinking 0.75–1 L of water altogether (within 5–10 min) in the morning immediately after waking up in a sitting (crossed leg or squatting) position. The changes in BP and other biochemical parameters were recorded.

Results: For the study group ($n = 34$), repeated measured analysis of variance revealed a statistically significant lowering of systolic BP (SBP): $F(2, 66) = 17.17, P \leq 0.0001$ and diastolic BP (DBP): $F(2, 66) = 7.31, P = 0.0014$. Moreover, *post hoc* analysis with Tukey–Kramer multiple comparisons found that the mean difference was statistically significant for baseline and end of 2 months – SBP: (14 [95% confidence interval, CI 8.23–19.77] mmHg, $P < 0.001$) and DBP: (6.35 [95% CI 2.22–10.48] mmHg, $P < 0.01$). The SBP and DBP at baseline versus the end of 2 months were 143.76 (13.40) versus 129.76 (14.27) mmHg and 84.35 (12.01) versus 78 (8.90) mmHg, respectively. In the study group, regression in the stage of HTN was observed where ten of 15 patients and 11 of 19 patients recovered from Stage I and Stage II HTN, respectively. Furthermore, 67.6% of the study group achieved a target BP of $<140/90$ mmHg at the end of 2 months.

Conclusion: The practice of morning ingestion of water does affect BP regulation and this practice can be a new potential lifestyle modification adjuvant with standard treatment guidelines for management of HTN in patients of diabetes mellitus.

Keywords: Blood pressure regulation, Diabetes mellitus, Hypertension, Lifestyle modification, Morning ingestion of water, Non-pharmacological intervention

INTRODUCTION

Hypertension (HTN) is among the exclusively researched, documented, and discussed health condition globally. It has encroached health system by its increasing prevalence^[1] both in developing as well as developed countries. At present, it accounts for 19% of the total deaths.^[2]

The coexistence of HTN and diabetes is not an uncommon condition.^[3] Nearly 40% of type I and 70% of type II diabetic patients are found to have blood pressure (BP) levels above 140/90 mmHg.^[4] The pathological factors such as endothelial dysfunction, vascular inflammation, arterial remodeling, and dyslipidemia are shared in common by them besides, obesity, sedentary lifestyle, and increased consumption of carbohydrates and fats^[5,6] which increase the risk of developing cardiovascular diseases. HTN optimum treatment study observed an almost 50% decline in cardiovascular events, when diastolic BP (DBP) lowered from 85 mmHg to 81 mmHg in diabetic but not in the non-diabetic subset.^[7]

The current guidelines aim at a target BP of $\leq 140/90$ mmHg in adults with both HTN and diabetes mellitus. The mainstay of treatment includes lifestyle modifications, dietary change, and antihypertensive drugs.^[8] Multiple antihypertensive drugs are being prescribed, for it is almost impossible to achieve this goal with monotherapy.^[9]

Water plays an essential role in regulating cellular homeostasis. Dehydration has been shown to elevate – blood viscosity, and hematocrit levels which act as independent risk factor for coronary heart diseases.^[10] A recent study has shown a strong association between hypohydration and HTN.^[11] At present, no markers exist to access the level of hydration at the population level.^[12]

In India, the practice of morning ingestion of water is traditionally known as Usha Paana Chikitsa, which has been practiced by many Indians for ages to remain healthy. This concept has been mentioned in Rasayan Adhyaay of Ashtang Hruday in Aryurveda. It has been mentioned that it can be followed in a person who is devoid of any illness to remain healthy. One of the implications is that it helps in controlling BP, but this has not been previously investigated and so no scientific evidence exists about same.

Hence, our study aimed to find out whether there is any effect of the practice of morning ingestion of water on BP, and simultaneously, if this is practiced as a lifestyle modification (adjuvant) in patients of diabetes mellitus (that is with illness) can the management of HTN be improved in them or not. Moreover, if yes what can be the possible mechanism behind it?

MATERIALS AND METHODS

Research was carried out at GMERS Medical College and Hospital Gotri, Vadodara, Gujarat India; under the

Department of Medicine; between July and October 2018, after obtaining permission from the Institutional Human Ethics Committee. The study was conducted on an outpatient department (OPD) basis. Participants were enrolled after obtaining written informed consent and they had rights to withdraw from the study. All the details of the participants were kept confidential.

- 68 participants were enrolled on the following inclusion and exclusion criteria:-

Inclusion criteria

Participants with Stage-I/Stage-II HTN (according to Joint National Committee [JNC] VIII guidelines), on stable antihypertensive and oral hypoglycemic medications for 4 weeks, with willingness to participate in the study were selected.

Exclusion criteria

Participants with – ischemic heart disease, heart failure, end organ damage, diabetic neuropathy, nephropathy, retinopathy, liver diseases, renal disease, and failure were not included in the study.

Objectives

The objectives of this study were to observe changes in systolic BP (SBP), DBP, fasting blood sugar (FBS), glycosylated hemoglobin, serum osmolality, serum cholesterol, and serum electrolytes.

Study procedure

For this study, 1000 patients were screened, out of which 110 were found eligible for the research. Ninety-three participants gave consent for the research and 68 participants finally managed to complete the follow-ups. There was no loss to follow-up.

The 68 participants were randomly and equally distributed into the study and control group, with equal gender representation in each group. The physical activity score was recorded using the Global Physical Activity Questionnaire^[13] and was similar for both groups.

BP was measured using a standard calibrated mercuric sphygmomanometer in a sitting position with arms supported at heart level. The participants were given adequate rest of 10 min before measuring BP. During the screening period, the BP in both arms was checked and participants with BP difference of <10 mmHg were included in the study; following which the BP was recorded in the right upper limb throughout the study. The BP at first was recorded by palpatory method to know the approximate SBP at the right radial artery, to

prevent the auscultatory gap. This was then followed by the auscultatory method in which the cuff was reinflated to 20 mmHg more than recorded by the palpation method and SBP and DBP were recorded in the right brachial artery of participants. The BP in each setting was recorded thrice at interval of 5 min and the average value was then taken into consideration. This BP monitoring was done at an interval of 1 month for a duration of 2 months and biochemical investigations were done at the start of the study and at the end of 2 months, for both the study and control group.

The control group followed standard treatment of diabetes mellitus and HTN. Study group in addition to the above practiced morning ingestion of water in which individuals were asked to drink 3–4 glasses (0.75–1 L) of water altogether (within 5–10 min) in the morning immediately after waking up, in a sitting (crossed leg or squatting) position. The water intake (in the study group) is in addition to the overall daily water intake by them. Few participants reported experiencing nausea and vomiting after drinking 3–4 glasses of water, these patients were asked to drink 1–2 glasses of water instead.

Statistics

Sample size

Calculated sample size-82, keeping Type-1 error α at 0.05, the power of study β at 0.8, clinically significant difference at 5 mmHg, and standard deviation of variable BP measured in mmHg at 8, the calculated sample size was 41 participants in the study and control group each. This was done using PS2 software.^[14]

Statistical analysis

Data analysis was done using microsoft excel sheet and graphpad instat 3 demo version. The comparison between study and control group was done by unpaired t-test. And within the group comparison were done by paired t-test for BP, biochemical parameters and hematocrit. BP analysis was done by repeated measured analysis of variance (ANOVA). For categorical data chisquare test was used. $P < 0.05$ was considered significant.

Data notation: n- no. of participants.

RESULTS

Sixty eight participants took part in the study, with the mean age of 54.06 (6.83) and 56.088 (5.151) in control and study group, respectively. There was no significant difference in baseline SBP and DBP between both the groups [Table 1]. For the study group: Repeated measured ANOVA ($n = 34$) revealed a statistical significant lowering

of SBP, $F(2, 66) = 17.17, P \leq 0.0001$. *Post hoc* analysis with Tukey–Kramer multiple comparison test found that the mean SBP difference was statistically insignificant for baseline and end of 1 month (E1M) (5.65 [95% confidence interval, CI -0.12 to 11.42] mmHg, $P > 0.05$) and statistically significant for E1M to end of 2 months (E2M) (8.34 [95% CI 2.58–14.12] mmHg, $P < 0.01$) and baseline to E2M (14 [95% CI 8.23–19.77] mmHg, $P < 0.001$) [Figure 1]. Moreover, repeated measured ANOVA for DBP revealed a statistical significant lowering of DBP, $F(2, 66) = 7.31, P = 0.0014$. *Post hoc* analysis with above-mentioned test found that mean DBP difference was statistically insignificant for baseline and E1M (1.71 [95% CI -2.42–5.86] mmHg, $P > 0.05$) and statistically significant for E1M to E2M (4.65 [95% CI 0.51–8.78] mmHg, $P < 0.05$) and baseline to E2M (6.35 [95% CI 2.22–10.48] mmHg, $P < 0.01$) [Figure 2].

For the control group. Repeated measured ANOVA ($n = 34$) showed a statistically insignificant difference between mean SBP [Figure 1] and DBP [Figure 2] of baseline, E1M and E2M: $F(2, 66) = 1.38, P = 0.26$ and $F(2, 66) = 2.79, P = 0.69$, respectively.

In the study group at the beginning, there were 15 patients in Stage-I and 19 patients in Stage-II of HTN. By E2M, 11 patients recovered from Stage-II (six had BP within the range of Stage-I, three had in a range of elevated BP (EBP) level, and two had BP within the normal range). For those who were initially in Stage-I HTN, four had BP in range of EBP and six had in normal range at E2M. The rest of the study group ($n = 11$) who remained within the same stage of HTN showed a significant decrease in both SBP=149.45 (13.5) to 142.54 (10.2); P -value (paired t -test) 0.0017 at 95% CI and DBP=86.4 (11.2) to 78.4 (11.6); P -value (paired t -test) 0.026 at 95% CI. In the study group, 67.6% had a target BP of <140/90 mmHg, as suggested in the JNC VIII guidelines. For reasons unknown, two patients did show an elevation in BP.

For the control group, at the beginning, there were 16 in Stage-I and 18 in Stage-II HTN. Four patients in the control group showed a reduction from stage-I to EBP levels and two patients showed Stage-II to Stage-I conversion. However,

Table 1: Baseline characteristics.

| Variable | Control group | Study group | P-value |
|---------------|---------------|-------------|---------|
| Age (in year) | 54.06±6.83 | 56.09±8.15 | 0.27 |
| Gender | | | |
| Male | 12 (18%) | 12 (18%) | 1.0* |
| Female | 22 (32%) | 22 (32%) | |
| SBP (in mmHg) | 140.29±12.94 | 143.77±13.4 | 0.281 |
| DBP (in mmHg) | 85.71±8.8 | 84.35±12 | 0.6 |

SBP: Systolic blood pressure, DBP: Diastolic blood pressure. Categorical data presented as number (%) and continuous data as mean±standard deviation. P -value by Chi-square test* or unpaired t -test. All data at 95% confidence interval

Table 2: Average SBP and DBP in study and control group at baseline, end of 1 month and end of 2 months.

| Category | Female | | Male | |
|--|----------------|----------------|----------------|----------------|
| | Control group | Study group | Control group | Study group |
| Baseline | | | | |
| SBP | 136.36 (9.54) | 144.54 (13.97) | 147.5 (15.52) | 142.33 (12.76) |
| DBP | 84 (6.98) | 82.63 (11.85) | 88.83 (11.07) | 87.5 (12.15) |
| At E1M | | | | |
| SBP | 136.54 (14) | 139.54 (17.68) | 137.5 (19.88) | 135.5 (19.11) |
| DBP | 82.55 (8.56) | 82.54 (10.15) | 80.67 (11.07) | 82.83 (9.28) |
| At E2M | | | | |
| SBP | 138.90 (13.31) | 131.54 (15.31) | 141.33 (13.47) | 126.5 (12.06) |
| DBP | 84.55 (6.6) | 79.54 (8.16) | 84.5 (9.84) | 75.17 (9.85) |
| P-value (between baseline and end of 2 months) | | | | |
| SBP | 0.232 | 0.0007* | 0.214 | 0.0002* |
| DBP | 0.697 | 0.17 | 0.342 | 0.0073* |

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, E1M: End of 1 month E2M: End of 2 months. Continuous data presented as mean (standard deviation). (*) indicates $P < 0.05$: Statistically significant. All data at 95% confidence interval. P value by paired t -test¹

seven patients depicted elevation in BP with a change from Stage-I to Stage-II HTN. Control group patients in whom stage of HTN remained unchanged did not show any significant change in SBP=144.6 (13.5) to 144.2 (13.5); P -value (paired t -test) 0.91, at 95% CI and DBP=86.72 (10.36) to 85.27 (8.01); P -value (paired t -test) 0.56 at 95% CI.

A significant decrease in SBP can be observed for both genders in study group. And a similar decrease in DBP in male study group. Females in study group have shown decrease in DBP but result isn't significant [Table 2].

DISCUSSION

To the best of our knowledge, we are among the first to study the effects of morning ingestion of water on HTN, adjuvant with standard treatment protocols. Few studies that have demonstrated the effect of water intake on BP, were done for short period of time. And in a normal individual or in patients with autonomic failure.

A handful of researches that can help to understand, explain, and support the findings of our research have been mentioned below as no similar studies have been conducted before.

Madhavulu *et al.*^[15] studied the immediate effects of water ingestion on BP. Their study noted an increase in both SBP and DBP with a significant fall in serum osmolality after ingestion of 2000 mL of water. Our study was conducted for 2 months duration and we noted a gradual and sustained fall in both SBP and DBP. Alongside a decrease in FBS [Figure 3], a minute fall in serum osmolality, and serum sodium [Table 3] was also observed within the study group. These differences in both studies are attributed to the amount of water consumed, the time interval between the sample collection and the duration of both the studies.

A study has shown that 1 week of hyperhydration in soccer players resulted in an increase in total body water in spite of increased urine output along with a minor fall in hematocrit that may be due to hemodilution.^[16] In our study, the intake of water in the study group is evident from the changes of hematocrit, serum sodium, and osmolality [Table 3]. The slight but significant fall in hematocrit along with a near significant fall of serum sodium and serum osmolality suggests that water intake results in minor degree of plasma volume expansion. Although 24 h urine output is a better indicator for knowing the overall increase in water intake but on an OPD basis, it was not feasible to be conducted. The fall noted in the above parameters would have been more if the blood sample was collected immediately after 30–60 min of water intake.^[15] Hence, the changes observed in parameters might be resultant of a steady state that developed over 2 months.

One crucial finding was a statistically significant fall in DBP in the male study group [Table 2] from 87.5 mmHg to 75 mmHg at end of 2 months from baseline and a similar trend was found in the female study group as well, though it was statistically insignificant; which suggest that there is lowering of peripheral vascular resistance.

Researchers have shown the presence of glycosuria even under euglycemic conditions, declining the concept of a universal glucose threshold.^[17] No significant change in urine glucose level was found in our study, which could be due to tests that are routinely practiced are less sensitive to detect such minor changes.

How elevated blood glucose, blood viscosity, and insulin resistance influence BP? [Algorithm 1]

In a study by Lowe *et al.*,^[18] elevated blood sugar level has been linked with raised blood viscosity. Increase blood

Table 3: Changes in biochemical parameters and hematocrit in control and study group from baseline and end of 2 months.

| Variables | Control group (P-value) | | Study group (P-value) | |
|-------------------------------|-------------------------|-------|-----------------------|-------|
| Serum cholesterol (mmol/L) | | | | |
| Baseline | 4.41 (1.45) | 0.266 | 4.49 (1.12) | 0.687 |
| E2M | 4.61 (1.56) | | 4.56 (0.99) | |
| Serum creatinine (micromol/L) | | | | |
| Baseline | 88.16 (29.24) | 0.563 | 79.32 (16.65) | 0.417 |
| E2M | 89.20 (29.88) | | 77.24 (15.59) | |
| Serum sodium (mmol/L) | | | | |
| Baseline | 134.56 (3.4) | 0.001 | 136.94 (2.65) | 0.055 |
| E2M | 135.82 (2.75) | | 135.88 (2.83) | |
| Serum potassium (mmol/L) | | | | |
| Baseline | 4.58 (0.43) | 0.243 | 4.42 (0.44) | 0.171 |
| E2M | 4.68 (0.58) | | 4.52 (0.5) | |
| Serum chloride (mmol/L) | | | | |
| Baseline | 103.77 (4.03) | 0.225 | 103 (2.62) | 0.344 |
| E2M | 104.5 (3.17) | | 103.56 (2.97) | |
| HBA ₁ C (%) | | | | |
| Baseline | 7.66 (1.76) | 0.957 | 7.705 (1.92) | 0.316 |
| E2M | 7.65 (1.87) | | 7.56 (1.898) | |
| Serum osmolality (mmol/kg) | | | | |
| Baseline | 286.46 (6.71) | 0.587 | 289.53 (5.97) | 0.055 |
| E2M | 286.93 (7.2) | | 287.7 (5.37) | |
| Hematocrit (%) | | | | |
| Baseline | 34.98 (4.74) | 0.28 | 37.53 (3.01) | 0.021 |
| E2M | 34.7 (4.85) | | 36.64 (3.14) | |

E2M: End of 2 months, HBA₁C: Glycosylated hemoglobin. Continuous data represented as mean (standard deviation). (*) indicates $P < 0.05$ statistically significant. All data at 95% confidence interval. P value by paired t -test²

glucose levels cause a decrease in deformability and an increase in aggregation of red blood cells (RBCs), raising the systolic and diastolic blood viscosity, respectively.

- Elevated viscosity increases the workload of heart and results in vascular inflammation.^[19] This may contribute to the initiation of cardiovascular diseases in both diabetic and hypertensive patients
- Increase viscosity also results in a decrease in blood flow rate,^[20] which causes insulin resistance at tissues that were sensitive to insulin thereby, contributing to hyperglycemia^[21]
- The body physiologically compensates for elevated viscosity by either increasing BP or by vasodilation;^[22] with atherosclerotic vessels comparatively less vasodilation is observed.^[23]

Insulin causes vasodilation by endothelial nitric oxide synthase production. Elevated blood glucose hampers the production

1. Approximately 8.99% fall in SBP of study group females and nearly 11.12% fall in SBP and 14.09% fall in DBP in study group male, at end of two months.
2. Near significant decrease in both serum osmolality and serum sodium levels in Study group.

of nitric oxide and facilitates production of hormones causing vasoconstriction which cannot be vanquished by high levels of insulin.^[24] Furthermore, diminished vasodilation is seen during state of insulin resistance.

- Presence of insulin resistance leads to HTN and *vice versa*.^[25] Hyperosmolality also contributes to insulin resistance.^[26] Thus, hyperosmolality is an indirect participating factor to increased BP.
- In addition, obesity which is itself a risk factor for insulin resistance also contributes to Increased BP by central activation of sympathetic nervous system.^[27]

The concept as to “how drinking water in morning is different from water intake throughout the day?” can be explained on the following basis:

Drinking water in the morning when the stomach is empty facilitates better and faster absorption of water from the proximal intestine due to increased gastric emptying. This can be explained on the basis of the study done by Leiper,^[28] in which the rate of gastric emptying was found directly proportional to the volume of water intake and inversely related to the energy density of fluid.

The second reason deals with the excretion part of water. The study by Shafiee *et al.*^[29] found that when a fixed amount of water is consumed in a brief duration (minutes) it's mainly excreted, whereas if the same taken over length of period (hours) it's retained.

- Therefore, in the morning when water (non-caloric drink) is ingested (0.75–1 L) within 5–10 min, the majority of the water will be excreted after the maximum possible level of dehydration is corrected.

A decrease in fluid intake becomes an important factor in old age. Mack *et al.*^[30] found that, with aging, there is a decrease in thirst. Even though the elderly have higher osmolality than younger individuals,^[31] they tend to drink less fluid to compensate for their fluid need.^[32]

Anastasio *et al.*,^[33] in a short-term study, found that in the fasting state, high hydration decreases glomerular filtration rate (GFR) and increases natriuresis. Two independent studies on dogs by Higgins and Meinders^[34] and Kurtzman *et al.*^[35] have shown that with a decrease in GFR and extracellular fluid expansion, there is natriuresis and decreased glucose reabsorption.

- The initial sudden increase in water content within the intravascular space will facilitate and improve peripheral circulation. And simultaneously, it will also help in glucose excretion through the kidney. As the circulation will improve, the insulin will reach the peripheral tissues, causing better glucose uptake by the same. As blood glucose will improve, it would cause a decrease in blood viscosity by preventing RBC aggregation. The natriuresis and

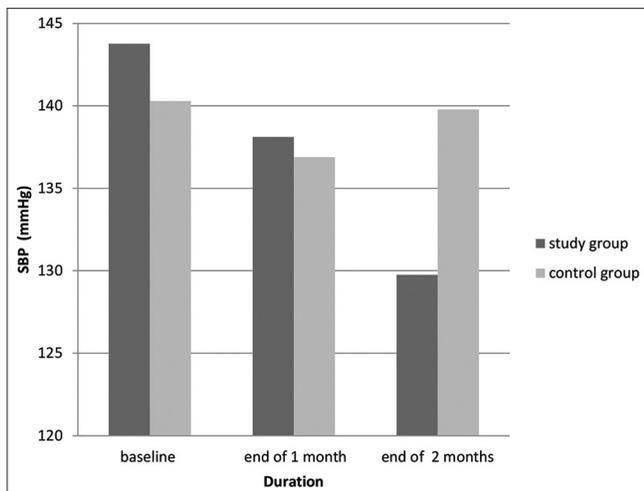


Figure 1: Graph compares the changes in Systolic blood pressure (SBP) between the study and control group.³

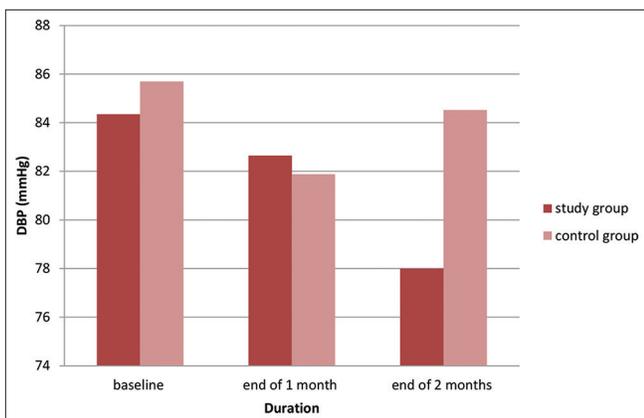


Figure 2: Graph compares the changes in Diastolic blood pressure (DBP) between the study and control group.⁴

glucose excretion will facilitate the lowering of both systolic and DBP, with a mild-moderate fall in blood sugar levels

- Therefore, morning ingestion of water will ensure effective water absorption from the intestine, correct dehydration, help in lowering plasma osmolality, and facilitate sodium and glucose excretion and in patients with normal kidney function, the water will also be excreted thereby preventing water intoxication.

3. The Graph shows the systolic blood pressure changes in both the study and control group from baseline till the end of two months. The X-axis denotes the time frame in months and Y-axis depicts average mean systolic blood pressure. The graphs clearly shows the sustained decrease in SBP in study group and constant with mild fluctuation in control group. SBP of study group-baseline average mean 143.77 (13.40) to 129.76 (14.27) mmHg at E2M, $P < 0.0001$. In control group, SBP remained relatively stable-baseline average mean 140.29(12.94) to 139.77 (13.21) mmHg at end of two months, $P = 0.26$. P -value by repeated measured ANOVA.

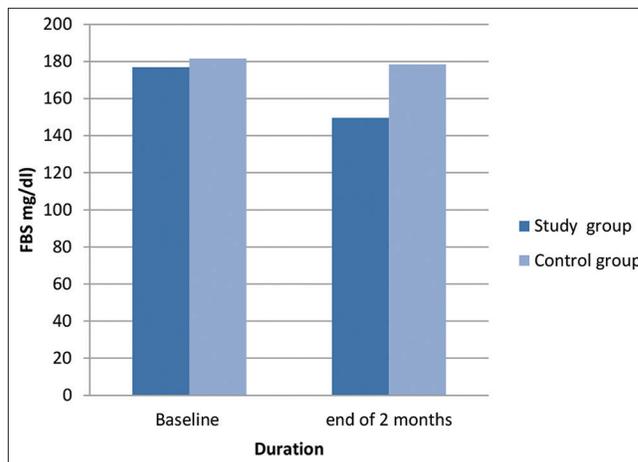


Figure 3: Graph compares the change in fasting blood sugar (FBS) between study and control group.⁵

The chances are likely that there are other mechanisms by which morning ingestion of water causes a reduction in BP. A long-term study is required to know its effect on cardiovascular pathophysiology, taking into account kidney function, hormonal analysis, BP homeostasis, blood sugar regulation, and blood viscosity.

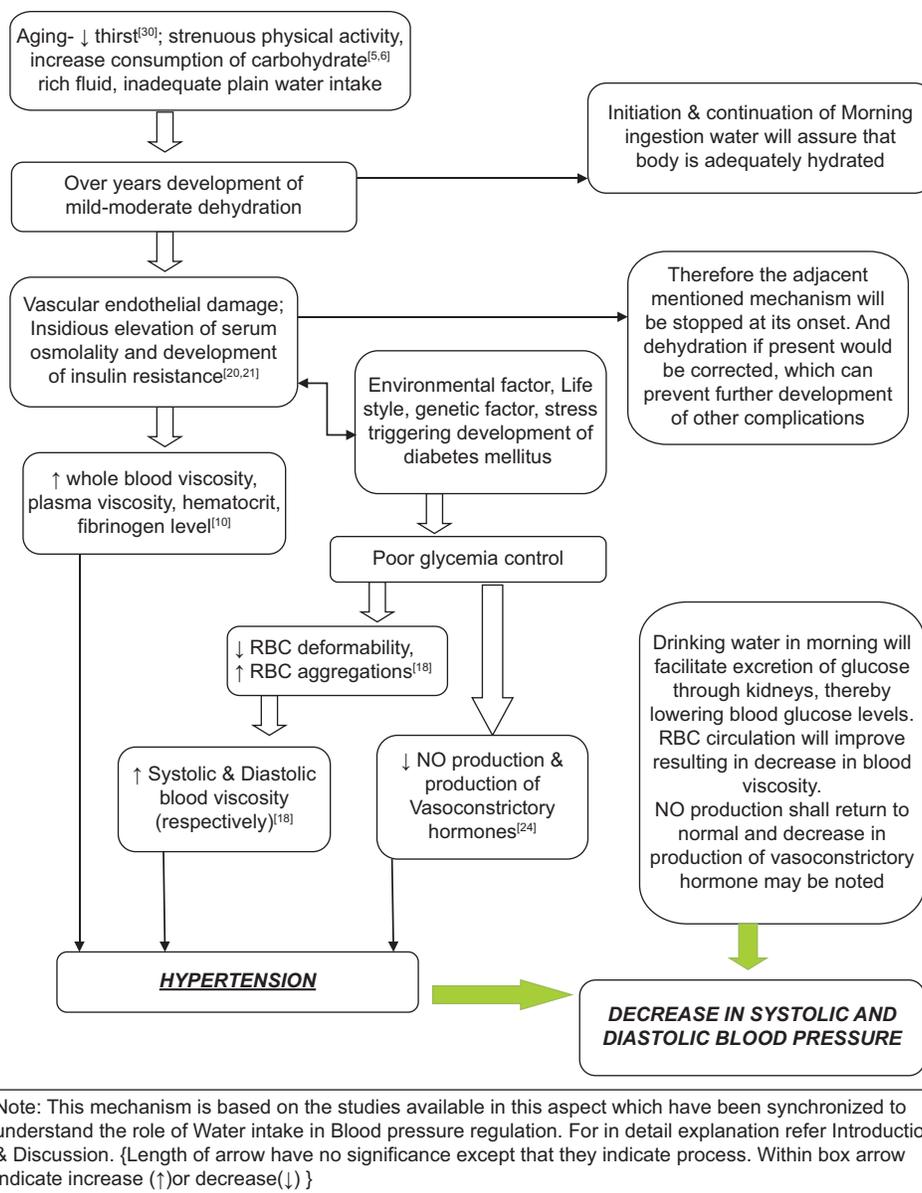
This is a lifestyle modification where we are ensuring that the daily requirement of water intake is met along with improving BP control; as this water intake is in addition to the regular intake by the person; without causing water intoxication.

With obvious reasons that this cannot be practiced in patients in whom volume overload is cautioned to prevent further progression and worsening of diseases such as congestive cardiac failure, renal failure, and diseases causing pulmonary edema.

4. The graph shows the changes in diastolic blood pressure in both the groups from baseline till end of two months. The X-axis denotes the time frame in months and Y-axis depicts average mean diastolic blood pressure. From the graph we have a clear interpretation that the study group shows sustained decrease in DBP whereas for the Control group mild fluctuation, similar to SBP can be noted.

DBP of study group-baseline average mean 84.35 (12.01) to 78 (8.90) mmHg at end of two months, $P = 0.0014$. In control group, DBP also remained relatively same, baseline average mean 85.70 (8.8) to 84.52 (7.74) mmHg at E2M; $P = 0.69$. P -value by repeated measured ANOVA.

5. Graph represents the changes in FBS from the baseline till end of 2 months. The Y-axis shows the fasting blood sugar levels in mg/dl and X-axis shows the duration. It can be noted that FBS has decreased in study group from baseline average mean 176 (72.27) to 149.62 (60.67) mg/dL at end of 2 months, $P = 0.016$ (significant); at 95% CI. And in control group no significant change was observed, $P = 0.695$ at 95% CI. P -value by paired t -test.



Algorithm 1: Hypothesized mechanism for control of blood pressure by practice of morning ingestion of water.

Why research has been done in patients with HTN and diabetes mellitus (DM) rather than isolated HTN?

- The very concept of the response of HTN to water through fluid expansion is based on the pathophysiology hypothesized in references 18–24, which explains that hyperglycemia leads to a decrease in RBC deformability and increases its aggregation. The increased viscosity causes an increase in the workload of the heart and also results in vascular inflammation. Hence, we focused on enrolling diabetic patients with HTN who were on stable medication for 4 weeks and yet having BP above the

desired level, thereby applying the practice of morning ingestion of water as adjuvant.

- In cases of isolated HTN, if raised BP is resultant of the above-mentioned pathophysiology; then yes a decrease in BP may be noted in a similar way. The practice of morning ingestion of water may have a potential effect on multiple sites of the pathophysiology of HTN like blood circulation, blood vessel compliance, Renin-angiotensin aldosterone system (RAAS), vascular inflammation, and autonomic nervous system. And thus, this remains a potential area of research for the future, as the most common cause of HTN is idiopathic.

The practice of morning ingestion of water may play a prophylactic role in preventing the development of HTN in diabetic patients and normal population.

This research brings a completely new insight into understanding the role of water intake (adequate hydration) in the regulation of BP by the practice of morning ingestion of water. To the best of our knowledge, previously no such study has been known to be conducted. Moreover, this new lifestyle modification will bring better outcomes in the management of HTN and cardiovascular diseases.

Limitations of our study

We do understand that we have not met our target sample size of 82 participants, but we have tried to achieve the best possible sample size in the defined time period, where the minimum duration required for therapy to reflect changes in BP was 2 months along with a proper follow-up. And now, hopefully, for the next study, based on encouraging results and patient compliance, we shall do it for a larger sample size.

CONCLUSION

The practice of morning ingestion of water does affect BP regulation and this practice can be a new potential lifestyle modification adjuvant with standard treatment guidelines for management of HTN in patients of diabetes mellitus.

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Author Contributions

Dr. Chirag Rathod: Guarantor, Study Design, Critical review, Final approval, Dr. Anavi Sheth: Guarantor, Conception, Study design, Data analysis and interpretation, Draft article, Dr. Poorva Tailor: Conception, Data collection, Draft article, Dr. Himanshu Rana: Critical review, Final approval, Dr. Varsha Godbole: Critical review, Dr. Ashka Shah: Data collection, Draft article.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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