Perioperative hemodynamics in hypertensive patients undergoing shoulder surgery with interscalene block in the sitting position: An observational study

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Original Article

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ABSTRACT

Objective: To investigate the effects of the interscalen block technique on blood pressure changes in medically controlled hypertensive patients undergoing shoulder arthroscopy in the sitting position.

Design: A prospective and observational study

Setting: Operating room and postoperative recovery area

Subjects: Sixty-four ASA I-II adult (medically controlled hypertensive (n=32) and normotensive (n=32) patients scheduled to have elective arthroscopic shoulder surgery with the interscalen block technique.

Intervention(s): Ultrasound-guided interscalen block administered using 15/cc 0.5% Bupivacaine and 5/cc 2% Lidocaine. Blood pressures and heart rate recorded at 5-minute intervals for 60 minutes.

Main outcome measures: The relationship between the interscalen block and 20% or more increase in the systolic blood pressure at any time interval compared to the baseline.

Results: None of the normotensive patients had 20% or more increase in the systolic blood pressure. However, 62.5% of the hypertensive patients had 20% or higher systolic blood pressure values after the interscalen block during the follow-up (*P*<.0001). Four hypertensive patient developed a hypertensive crisis after interscalene block.

Conclusions: Consequently, interscalen block caused an increase in the blood pressures of medically controlled hypertensive patients. In daily practice, caution is warranted when selecting the anesthesia type, especially in patients with uncontrolled hypertension and with comorbidities, who cannot tolerate acute upsurges in blood pressure.

KEY WORDS: carotid sinus baroreceptors, complication, hypertension, interscalen block, ultrasound

INTRODUCTION

Interscalene Block (ISB) is a regional anesthesia technique applied by blocking the roots or trunks of the brachial plexus between the anterior and middle scalene muscles. The ISB technique in shoulder surgery has several advantages, including less post-operative pain, reduced opioid requirements and opioid-related side effects and higher patient satisfaction.[1,2] However, significant complications associated with ISB may develop. Most of the problems are related to the spread of the local anesthetic agent to the surrounding anatomical structures via the fascial sheath.[3] These anatomical structures can be the stellate ganglion, phrenic nerve, and contralateral brachial plexus.[4-6]

It was shown that local anesthetic spread after ISB might extend to the carotid sinus receptors.[7] In fact, carotid sinus baroreceptors play an essential role in the dynamic control of blood pressure.[8] There are limited case reports about the disturbances in the autonomic nervous system and the presence of hypertension as a result of an undesired blockade of carotid baroreceptors with local anesthetics after ISB.[3, 9] However, perioperative hypertension increases the frequency of blood loss, renal damage, as well as cardiovascular and cerebrovascular events.[10] Therefore, especially in hypertensive patients, it is vital to preserving the hemodynamic stability during the perioperative period.

The effects of ISB in hypertensive patients on blood pressure changes during shoulder arthroscopic surgery while sitting are is still not well elucidated. We aimed to investigate the effects of the ISB technique on blood pressure changes in hypertensive patients undergoing shoulder arthroscopy in the sitting position.

SUBJECTS AND METHODS

Approvals for this prospective and observational research were obtained from the Necmettin Erbakan University Ethical Committee (Approval number: 2017/938). This study was carried out between July 2017 and February 2018 at the Anesthesiology and Reanimation Clinics of Konya Education and Research Hospital. Written informed was consent obtained from all participants.

Inclusion criteria

We enrolled ASA I-II patients who were scheduled to have elective shoulder surgery with the ISB technique, who were normotensive or had controlled HT.

Exclusion criteria

Participants were excluded if vital signs might be affected by regional anesthesia (history of chronic opioid or benzodiazepine use, severe renal and hepatic insufficiency, advanced respiratory and cardiovascular disease eg), ASA-III class and above, BMI>35 kg/m^2, have uncontrolled hypertension or without regular medical treatment, are not eligible for ISB application (allergy to local anesthetic drugs and diaphragm paralysis), and in case of failed ISB attempt.

Design of the study

The patients were divided into two groups as normotensives (Group N), and hypertensives (Group H). The demographic data (age, height, weight, gender, and intervention side), antihypertensive drug use, history of hypertension, and presence of additional diseases were recorded.

The same experienced anesthesiologist performed all ISB applications. Patients were placed in the 45 degrees sitting or “beach chair” position, which could be achieved by elevating the back of the operating table, and this position was maintained during the study period. Noninvasive blood pressure, peripheral oxygen saturation, and electrocardiography monitoring was performed in all patients. An intravenous 16G or 18G cannula was placed in the antecubital region followed by the infusion of 0.9% sodium chloride solution. All patients were lightly sedated with 1-2 mg midazolam, and the sedation was assessed using the Ramsay sedation score. [11]

After the appropriate aseptic conditions achieved, ISB was applied using both a nerve stimulator (Pajunk, Multistim Sensor, Germany) and USG guidance (Esaote brand MyLabFive-Esaote Europe BV Philipsweg 1 6227 AJ Maastricht The Netherlands). The block was administered with 15/cc 0.5% Bupivacaine (Bustesin 0.5%, Verm Drugs), and 5/cc 2% Lidocaine (Jetmonal Lidocaine Hydrocloride 20 mgml^{-1},Adeka Drugs) without adrenaline. The effectiveness of the A sensorial block was evaluated by the pinprick test at the fifth and sixth cervical dermatomes, and the loss of shoulder abduction was considered as a successful motor block.

Blood pressure (BP) and heart rate (HR) of the patients were recorded at 5-minute intervals for 60 minutes. The time intervals were named as; “T0: the baseline,”“ T1: after premedication and before ISB, ”“T2: after ISB,” and “T5-T60 (each 5-minute intervals in sequence). During the study, 20% or more increase in the systolic blood presssure (SBP) at any time interval compared to the T1 time was defined as hypertension .[12] Nitroglycerin was administered in case of hypertension. On the other hand, a “hypertensive crisis” was defined as the mean SBP ≥180 mmHg or diastolic blood pressure (DBP) ≥110 mmHg at any time interval.

Sample size calculation

In the light of a pilot data, 29 patients in each group should be included in the study to calculate 20% or more systolic blood pressure compared with T1 time by a 2x2 mixed ANOVA model using 80% power for 0.28% eta-square effect size and 5% type-1 error. The sample size calculation revealed a total of 64 patients after considering a 10% drop-out rate.

Statistical analysis

The SAS University Edition 9.4 (SAS Institute Inc., Cary, NC, USA) program was used for data analysis. The continuous variables were expressed as the mean and standard deviation (SD), and categorical variables were expressed as numbers and percentages. The SD values for continuous variables were provided in parentheses next to their mean values, and the proportions of categorical variables were specified in brackets along with their numerical values. The independent samples t-test and mixed effect models ANOVA were used in the analysis of continuous variables. The Chi-square test was used to compare categorical variables, and P <.05 was considered as statistically significant.

RESULTS

A total of 79 cases were included in the study. After the exclusion criteria, data for the remaining 64 cases were evaluated (Figure 1). Demographic data of the patients are shown in Table 1. The mean duration of diagnosis was 8.1±4.9 years in the hypertensive patients. The Ramsay sedation score was similar between the groups (P>.05). There was no statistically significant difference between the two groups concerning the HR changes over time. However, fort the HR values, the time and group effects were significant in both groups (P <.0001 and P=.013, respectively), but there was no statistically significant difference regarding time-group interaction (P=.44) (Figure 2). There was a statistically significant difference between the two groups concerning the SBP changes over time. Also, the time effect, group effect, and time-group interaction were statistically significant between the two groups (P <.0001, P <.0001, and P <.0001, respectively). None of the patients in Group N had 20% or more increase in the systolic blood pressure. However, 62.5% of the hypertensive patients had 20% or higher SBP values after ISB during the follow-up (P <.0001) (Figure 3). In group H, patients with high BMI, advanced age, female sex, and left-sided surgery had 20% or more increase in SBP. However, these increases were not statistically significant (P >.05).

Diastolic blood pressure (DBP) changes over time were similar between the groups over time. While the time effect was significant between the two groups (*P* <.0001), there was no statistically significant difference in the group effect and time-group interaction (*P*=.06 and *P*=.0505, respectively)(Figure 4). A total of 16 patients (50%) in group N and 27 patients (84.3%) in group H had 20% or more increase in the DBP after ~~the~~ ISB when each time interval was compared with T1 (*P*=.003). In all participants, patients with high BMI, advanced age, female sex, and left-sided surgery had 20% or more increased in the DBP. However, these increases were not statistically significant (*P* >.05).

The mean blood pressure (MBP) changes were similar between the two groups over time. While the time effect and group effect were significant between the two groups (*P* <.0001 and *P*=.0004, respectively), there was no statistically significant difference regarding time-group interaction (*P*=.09) (Figure 5). There was a 20% or more increase in the mean blood pressure in seven patients in Group N, 18 patients in Group H, and this difference was statistically significant (*P*=.005). In all participants, patients with high BMI, advanced age, female gender, and left-sided surgery had 20% or more increased in the MBP. However, these increases were not statistically significant (*P* >.05). Horner syndrome was observed in 18 of the patients (8 in Group H, 10 in Group N). In group H, 4 patients (12.5%) had hypertensive crisis after the ISB application.

DISCUSSION

Hypertension is a progressive cardiovascular disease affecting approximately 30-45% of the adult population in Europe, and its prevalence is rapidly increasing with age.[13] Therefore, ISB is frequently applied in hypertensive patients as well as normotensive patients in the daily anesthesia practice. In this prospective observational study, we detected that 62.5% of the hypertensive patients, who were under medical treatment, had 20% or higher SBP values after ISB compared to the T1 time.

There are few cases in the literature about ~~the~~ high blood pressure levels occuring in the early period after ISB administration.[3,9,14] Gianesello *et al* compared the blood pressure changes with ISB and reported ~~that~~ higher SBP and DBP values in patients who underwent blockage with neurostimulation than patients who underwent blockage with USG at the 15th minute.[15] The authors suggested that ISB, administered in normotensive patients using USG-guided and low-dose local anesthetics, could reduce the incidence of increases in the blood pressure.

The spread of local anesthetic agents to the surrounding tissues can explain high blood pressure values associated with ISB. Winnie has shown that the brachial plexus sheath is a tubular extension of the prevertebral fascia and that local anesthetic agents have both a downward and upward spread in the cervical area in interscalene brachial plexus injections.[16] Yang *et al* demonstrated the diffusion of the contrast agent given by the interscalene and supraclavicular approach into the brachial plexus sheath through computed tomography and reported greater perimuscular and intramuscular accumulation in the interscalene approach.[7] They also reported that the contrast agent reached the anterior scalene muscle in 90% of the patients and reached the carotid sheath in 50% of the patients. The vagus in the carotid sheath and the phrenic nerve behind it can involuntarily be blocked during the brachial plexus anesthesia with the interscalene approach.[8] In the present study, autonomic nerves from the carotid baroreceptors are probably suppressed or blocked by the spreading of the local anesthetic agent to the barosensitive region, possibly due to the anatomical neighborhood, and for this reason, we believe that an unresponsive sympathetic activity and increase in blood pressure may occur.

Gianesello et al. argued that the incidence of this unintended hemodynamic event could be reduced by USG-guided and low-dose local anesthetic usage in normotensive patients.[15] Although ISB was performed with USG guidance and low dose local anesthetic in our study, there was an increase in blood pressure compared to the baseline values in both hypertensive and normotensive patients. However, patients who had 20% or more increase in blood pressure values compared to the T1 time were statistically more in the hypertensive group than the normotensive group.

Changes in cardiovascular functions during the aging process are accompanied by compensated baroreflex integrity deterioration.[17] High blood pressure in the elderly patients may be due to an age-related decrease in the baroreflex sensitivity, changes in basal sympathetic nerve activity, and a decrease in systemic vascular response. In the present study, the mean age of the patients was higher than 50 years. Therefore, despite the low-dose local anesthetics, the age factor may be responsible for elevated blood pressure in the participants.

Besides age, many studies have pointed out that gender is an effective factor in the autonomic control of the heart rate and blood pressure regulation.[18-20] It is known that sympathetic vascular regulation in men and parasympathetic effect in women are more dominant. Also, resting sympathetic vasomotor tonus tends to decrease in women, whereas baroreflex blood pressure buffering is less effective in women than men.[21,22] Since women have a better parasympathetic activity, it's known that even partially reduced vagal afferents may cause stronger high-pressure baroreflexes.[20] In our study, the relationship between the elevation of blood pressure and gender could not be elucidated clearly due to the high number of female patients. However, all of the patients who developed hypertensive crisis were women.

In the perioperative period, various factors such as anxiety, pain, and discomfort may also be involved in increased blood pressure. Most patients are concerned about anesthesia and surgical procedures. For this reason, light sedation may be useful to reduce potential anxiety and prevent undesirable discomfort before performing a peripheral nerve block. Therefore, all patients were treated with midazolam before the ISB.

The purpose of controlling perioperative blood pressure is to maintain the peripheral organ function. In general, since the safe blood pressure limit is not known in hypertensive patients, it is recommended to keep the blood pressure 20% compared to the initial values.[22] Patients with hypertension are more likely to have intraoperative blood pressure lability, which may lead to myocardial ischemia. There are no randomized clinical trial data about the optimal blood pressure during the intraoperative period. However, it is recommended to provide a blood pressure lower than 130/80 mmHg in the intraoperative period, especially in people who are older and have additional comorbidities.[23] In a case report, angina was reported due to high blood pressure after brachial plexus block. Accordingly, the authors suggested that contralateral baroreceptor mechanisms could not prevent hypertensive responses in patients with uncontrolled hypertension.[9] In the present study, SBP over 180 mmHg was detected in four patients. However, there was only one patient who had a 160 mmHg or higher SBP ~~value~~ at one hour after ISB administration, and none of the patients had additional cardiovascular complications such as arrhythmia and angina. Probably, the effective contralateral baroreceptor mechanism in medically controlled hypertensive patients prevented the prolonged duration of this complication.

A relationship was detected between increased diastolic pressure (-notably > 90 mmHg-) and postoperative mortality in a recent analysis of more than one million patients.[24] These findings are quite striking when considering that diastolic hypertension is a more potent cardiovascular risk factor than systolic hypertension up to the age of 50 in non-surgical environments. We observed an increase in the SBP after ISB only in the hypertensive group. 20% or more increase in the DBP and MBP values after ISB were detected in both the normotensive and hypertensive groups. However, these increases were significantly higher in the hypertensive group. On the other hand, age 50 is the threshold; SBP is a stronger cardiovascular risk factor than DBP after this age.[25] Therefore, we think that the increase in SBP is more critical in the elderly.

There are several limitations to this study. First, because of the high number of females, the relationship between elevated blood pressure and sex could not be evaluated. However, all patients with the hypertensive crisis were females. Second, the hemodynamic parameters of the patients were followed up for 60 minutes after the ISB. Another limitation was that the hemodynamic follow-up was performed in a 45-degree sitting position to exclude the effect of possible hemodynamic changes during the transition from supine to sitting position. Further studies are also needed to check the additional contribution of position changes on hemodynamics.

CONCLUSION

In conclusion, ISB with low dose local anesthetic under the guidance of USG resulted in an increase in blood pressure levels in hypertensive patients, whose blood pressure was medically controlled. In four patients, the blood pressure reached the level of hypertensive crisis. However, no cardiovascular complications were observed in any of the patients. In daily practice, caution is warranted when selecting the anesthesia type, especially in patients with uncontrolled hypertension and with comorbidities, who cannot tolerate acute upsurges in blood pressures.

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Contribution: MST contributed to designing the study and preparation of the manuscript. He also contributed to data collection and conduction of the study. BK contributed to data analysis, writing, and design of this study.

REFERENCES

1.Long TR, Wass CT, Burkle CM. A perioperative interscalene blockade: an overview of its history and its current clinical use. J Clin Anesth. 2002; 14(7):546–556.

2.Fredrickson MJ, Stewart AW. Continuous interscalene analgesia for rotator cuff repair: a retrospective comparison of the effectiveness and the cost in 205 patients from a multi-provider private practice setting. Anaesth Intensive Care. 2008; 36 (6):786-791.

3.Jahagirdar SM, Prabhu CR, Parthasarathy S. Transient Hypertension after an Interscalene Block-The Presentation of a Rare Complication with an Anatomical Explanation. J Clin Diagn Res. 2012; 6 (10):1768.

4.Seltzer JL. Hoarseness and the Horner's Syndrome after an interscalene brachial pleksus block. Anesth Analg. 1977; 56 (4):585-586.

5.Urmey WF, McDonald M. A hemidiaphragmatic paresis during an interscalene brachial pleksus block: its effects on the pulmonary function and the chest wall mechanics. Anesth Analg. 1992; 74 (3):352-557.

6.Urmey WF, Talts KH, Sharrock NE. One hundred percent incidence of hemidiaphragmatic paresis associated with interscalene brachial plexus anesthesia as diagnosed by ultrasonography. Anesth Analg. 1991; 72 (4):498-503.

7.Yang WT, Chui PT, Metreweli C. Anatomy of the normal brachial plexus revealed by sonography and the role of sonographic guidance in anesthesia of the brachial plexus. Amj Roentgenol. 1998; 171(6):1631-1636.

8.Timmers HJ, Wieling W, Karemaker JM, Lenders JW. Denervation of carotid baro-and chemoreceptors in humans. J Phycol. 2003; 553 (1):3-11.

9.Chakithandy S, Kelly P, Barron J. Unexpected outcome (positive or negative) including adverse drug reactions: Hypertensive emergency as a complication of brachial plexus block. BMJ case reports. 2011; bcr0120113754.

10.Lonjaret L, Lairez O, Minville V, Geeraerts T. Optimal perioperative management of arterial blood pressure. Integrated blood pressure control. 2014; 7:49-59.

11.Ramsay MAE, Savage TM, Simpson BRJ, Goodwin R. Controlled sedation with alphaxalone-alphadolone. BMJ. 1974; 2(5920):656-659.

12.Goldberg ME, Larijani GE. Perioperative hypertension. Pharmacotherapy. 1998; 18 (5):911-914.

13.Lapage KG, Wouters PF. The patient with hypertension undergoing surgery. Curr Opin Anesthesio. 2016; 29 (3):397-402.

14.Hernandez A, Salgado I, Agreda G, Botana C, Casas M, Nogueron M. Hypertensive crisis after interscalene block for shoulder surgery: A-485. Eur J Anaesth. 2006; 23:126.

15.Gianesello L, Magherini M, Pavoni V, Horton A, Nella A, Campolo MC. The influence of interscalene block technique on adverse hemodynamic events. J Anesth. 2014; 28 (3):407-412.

16.Winnie AP. Interscalene brachial plexus block. Anesth Analg. 1970; 49 (3):455-466.

17.Laitinen T, Hartikainen J, Vanninen E, Niskanen L, Geelen G, Länsimies E. Age and Gender Dependency of Baroreflex Sensitivity in Healthy Subjects. J Appl Physio. 1998; 84 (2):576-583.

18.Ryan SM, Goldberger AL, Pincus SM, Mietus J, Lipsitz LA. Gender and Age-Related Differences in Heart Rate Dynamics: Are Women More Complex than Men? J Am Coll Cardiol. 1994; 24 (7):1700-1707.

19.Liao D, Barnes RW, Chambless LE, SimpsonJr RJ, Sorlie P, Heiss G. Age, Race, and Sex Differences in Autonomic Cardiac Function Measured by Spectral Analysis of Heart Rate Variability: The ARIC Study. J Am Coll Cardiol. 1995; 76 (12):906-912.

20.Huikuri HV, Pikkuja SM, Airaksinen KJ, Ika¨ heim MJ, Rantala AO, Kauma H, *et al*. Sex-related differences in autonomic modulation of heart rate in middle-aged subjects. Circulation. 1996; 94 (2):122-125.

21.Evans JM, Ziegler MG, Patwardhan AR, Ott JB, Kim CS, Leonelli FM, *et al*. Gender differences in autonomic cardiovascular regulation: spectral, hormonal, and hemodynamic indexes. J Appl Physio. 2001; 91 (6):2611-2618.

22.Lines D. Hypertension and Anaesthesia. S Afr Fam Pract. 2014; 56 (5):9-15.

23.Williamson JD, Supiano MA, Applegate WB, Berlowitz DR, Campbell RC, Chertow GM, *et al*. Intensive vs standard blood pressure control and cardiovascular disease outcomes in adults aged≥ 75 years: a randomized clinical trial. Jama. 2016; 315 (24):2673-2682.

24.Venkatesan S, Myles PR, Manning HJ, Mozid AM, Andersson C, Jørgensen ME, *et al*. Cohort study of preoperative blood pressure and risk of 30-day mortality after elective non-cardiac surgery. Br J Anaesth. 2017 ;119 (1):65-77.

25.Franklin SS, Larson MG, Khan SA, Wong ND, Leip EP, Kannel WB, *et al*. Does the relation of blood pressure to coronary heart disease risk change with aging?: The Framingham Heart Study. Circulation. 2001; 103 (9):1245-1249.

Table 1: Demographic and clinical characteristics of the participants.

Characteristics	**All patient, n=64**	**Group H, n=32**	**Group N, n=32**	***P* value**
Male/female (n)	18/46	4/28	14/18	.005
Age (years)	58.5±5.1	59.4±4.4	57.6±5.6	.17
BMI (kg m^{-2})	29.5±3.4	29.5±3.4	28.8±3.0	.10
Block side (right/left) (n)	42/22	19/13	23/9	.29
ASA1/ASA2 (n)	17/47	0 /32	17/15	<.0001

(Values are presented as mean ± SD or number of patients)

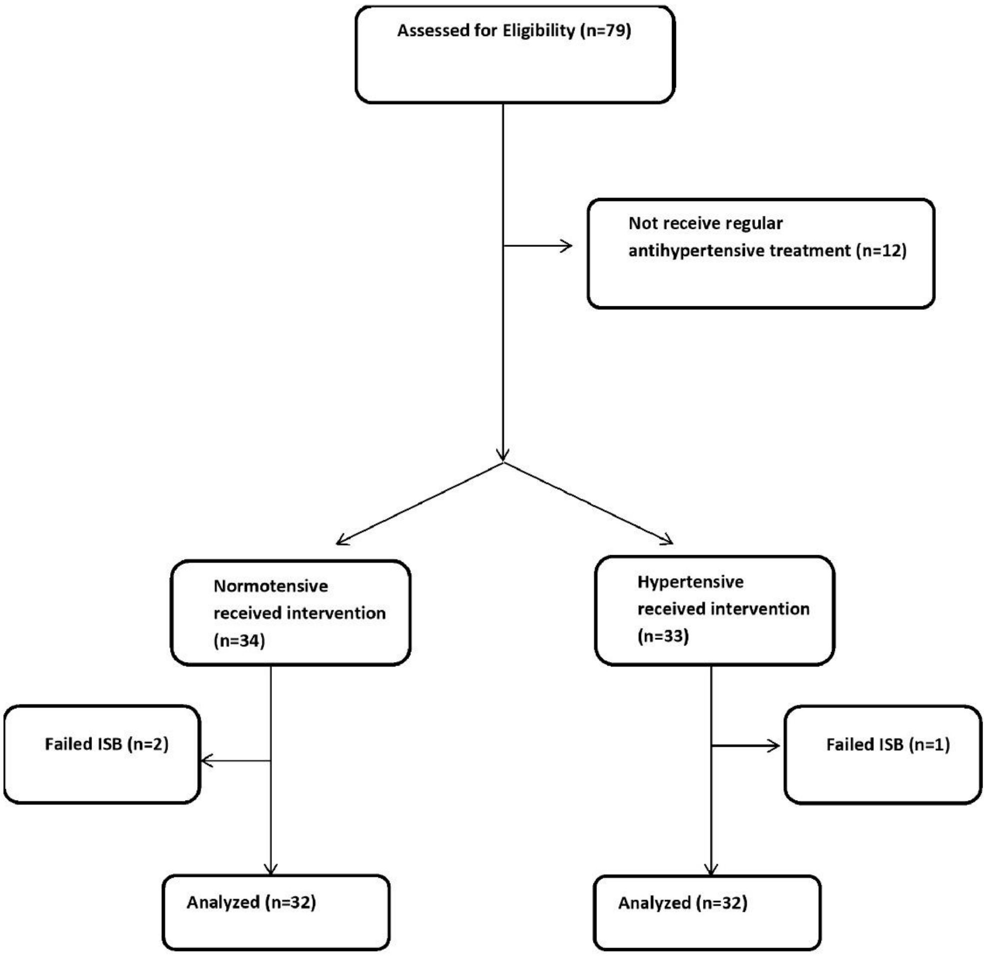

Figure 1. Consort diagram of the patients included in study.

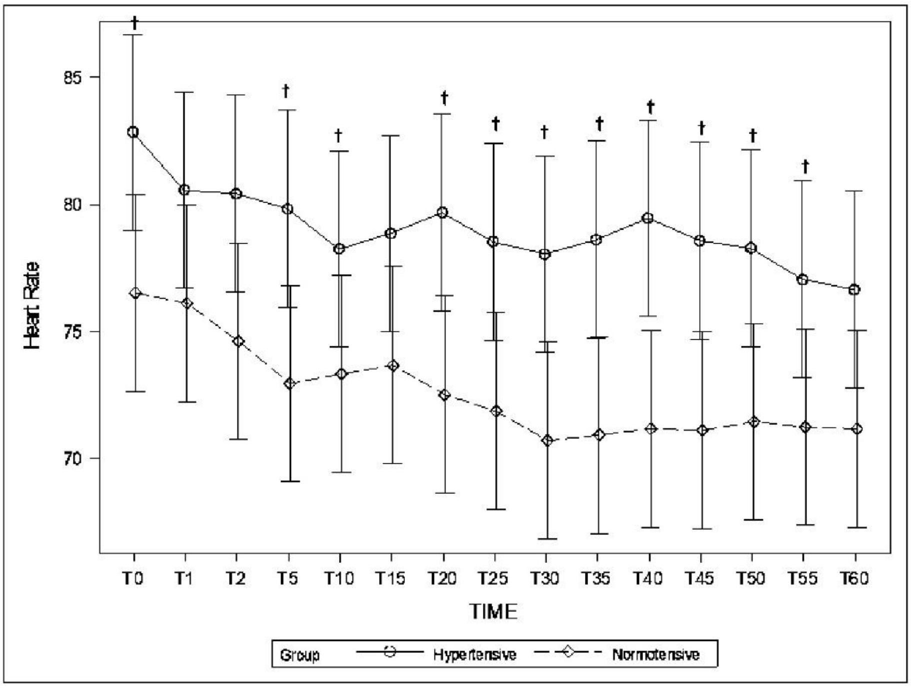

Figure 2. Heart rate values in groups according to time, †: $P < .05$

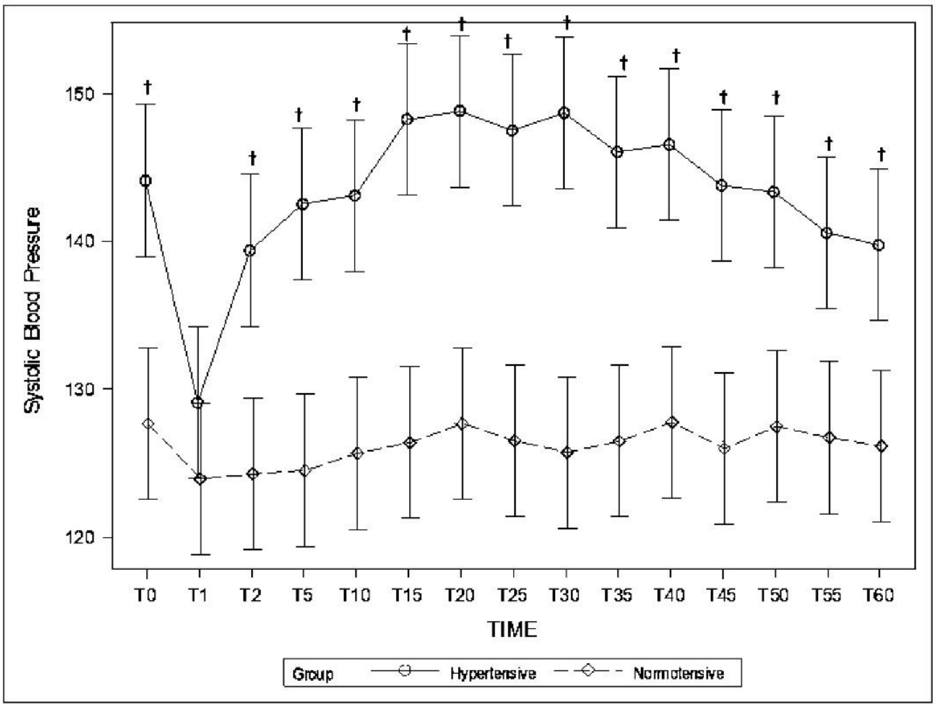

Figure 3. Systolic arterial blood pressure values in groups according to time, †: P <.05

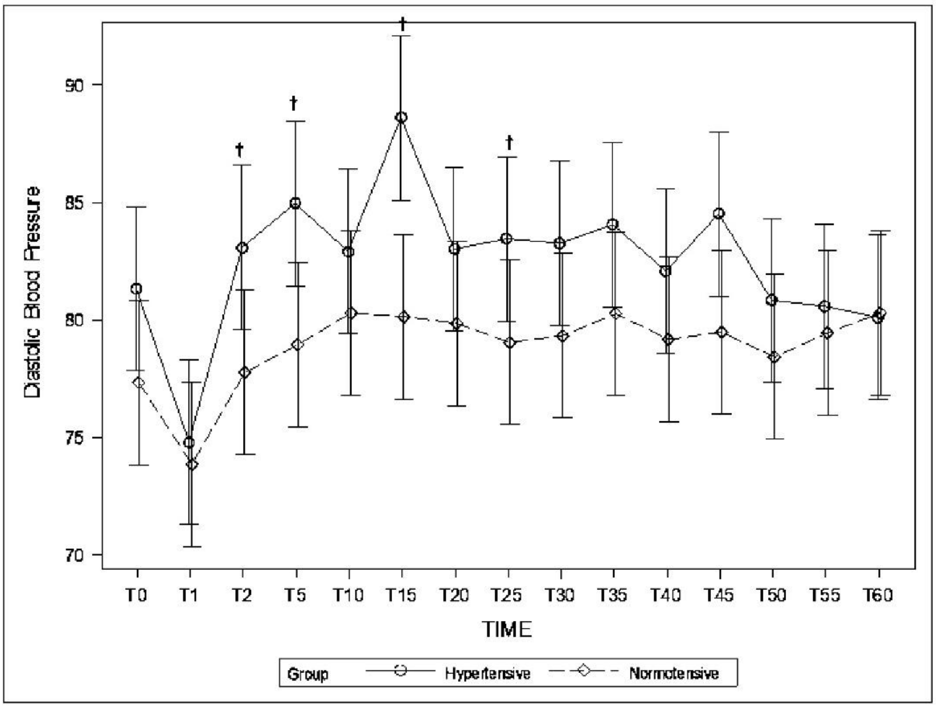

Figure 4. Diastolic arterial blood pressure values in groups according to time, †:*P* <.05

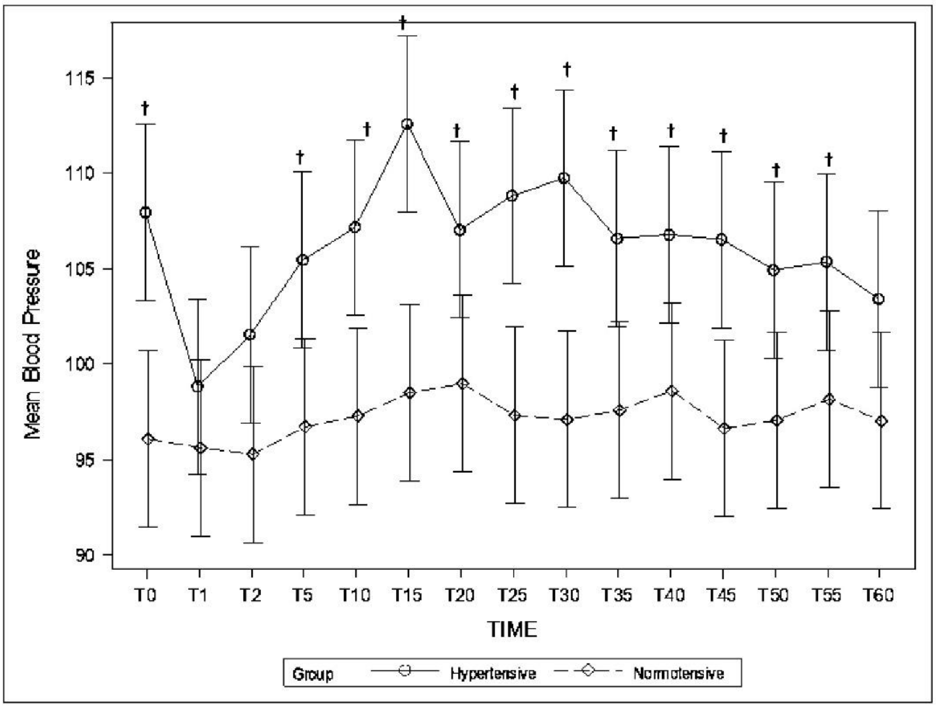

Figure 5. Mean arterial blood pressure values in groups according to time, †: *P* <.05