Inspiratory muscle training reduces blood pressure and sympathetic activity in hypertensive patients: A randomized controlled trial

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ABSTRACT

Background: Autonomic imbalance, characterized by sympathetic hyperactivity and diminished vagal tone, is a known mechanism for essential hypertension. Inspiratory muscle training (IMT) demonstrates beneficial outcomes in a number of cardiovascular populations, which may potentially extend to patients with hypertension. The aim of this study was to further elucidate the effects of IMT on blood pressure and autonomic cardiovascular control in patients with essential hypertension.

Methods: Thirteen patients with hypertension were randomly assigned to an eight-week IMT program (6 patients) or to a placebo-IMT (P-IMT, 7 patients) protocol. We recorded RR interval for posterior analysis of heart rate variability and blood pressure, by ambulatory blood pressure monitoring (ABPM), before and after the program.

Results: There was a significant increase in inspiratory muscle strength in the IMT group (82.7 ± 28.8 vs. 121.5 ± 21.8 cmH2O, P = 0.001), which was not demonstrated by P-IMT (93.3 ± 25.3 vs 106.1 ± 25.3 cmH2O, P = 0.05). There was also a reduction in 24-hour measurement of systolic (133.2 ± 9.9 vs 125.2 ± 13.0 mm Hg, P = 0.02) and diastolic (80.7 ± 12.3 vs 75.2 ± 1.0 mm Hg, P = 0.02) blood pressure, as well as in daytime systolic (136.8 ± 12.2 vs 127.6 ± 14.2 mm Hg, P = 0.008) and diastolic (83.3 ± 13.1 vs 77.2 ± 12.2 mm Hg, P = 0.01) blood pressure in the IMT group. In relation to autonomic cardiovascular control, we found increased parasympathetic modulation (HF: 75.5 ± 14.6 vs. 84.74 ± 7.55 n.u, P = 0.028) and reduced sympathetic modulation (LF: 34.67 ± 20.38 vs. 12.81 ± 6.68 n.u; P = 0.005). Moreover, there was reduction of cardiac sympathetic discharge (ILF) in IMT group (P = 0.01).

Conclusions: IMT demonstrates beneficial effects on systolic and diastolic blood pressure as well as autonomic cardiovascular control in hypertensive patients.

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1. Introduction

Hypertension is known to be a major risk factor for cardiovascular morbidity and mortality [1–4]. Moreover, its severity is positively related to organ damage and the development of heart, kidney and liver failure [5]. One of the multifactorial causes of essential hypertension is autonomic imbalance, which is primarily treated by pharmacologic management [6].

Recently, several investigations have reported on the effects of non-pharmacologic interventions on blood pressure management in this population [7, 10–15]. Among these lines, previous studies have reported autonomic cardiovascular control alterations with different breathing patterns [7, 10–15], implicating a ventilatory influence on hemodynamics. Based on these results, one may poset that breathing exercises and respiration control are a viable treatment option for hypertension with a more favorable side effect profile compared to pharmacology.

Findings from previous breathing exercise programs in patients with hypertension, without an imposed external resistance or any documented improvement in inspiratory muscle strength and/or endurance, suggest that the resultant reduction in respiratory rate lowers blood pressure (BP) by favorable modulation of cardiovascular reflexes [7, 11].

Inspiratory muscle training (IMT), which does impose an external resistance to the respiratory musculature, has demonstrated beneficial training effects in patients with cardiovascular disease, specifically in patients with chronic heart failure [16]. However, to our knowledge, the effect of IMT in patients with essential hypertension has not been investigated. Moreover, there appear to be no reports about its effects on blood pressure and cardiovascular autonomic control in any cohort.
Therefore, the purpose of this randomized trial is to test the hypothesis that an eight-week program of IMT would result in both a reduction in arterial blood pressure and improvement of autonomic cardiovascular control in patients with essential hypertension.

2. Materials and methods

2.1. Study design/selection criteria

A prospective, randomized, controlled, double blinded trial was conducted in patients with a diagnosis of essential hypertension (of all stages) who were recruited from the Ambulatory of Hypertension of Instituto de Cardiologia do Rio Grande do Sul.

The primary endpoint of this study was to evaluate the effects of IMT on blood pressure and the secondary endpoint was to assess the impact of the intervention on autonomic cardiovascular control variables, inspiratory muscle strength and functional capacity. 

Inclusion criteria for this study were: previous Hypertension diagnosis, i.e. systolic cardiovascular control variables, inspiratory muscle strength and functional capacity. 

The primary endpoint of this study was to evaluate the effects of IMT on blood pressure and improvement of autonomic cardiovascular control in patients with essential hypertension.

2.2. Inspiratory muscle training

The enrolled patients performed IMT or placebo-IMT (P-IMT) for 8 weeks. Before and after the intervention, electrocardiogram (ECG), inspiratory muscle function, blood pressure and functional capacity were assessed. Subjects and main investigators were unaware of group allocation for any subject. No changes were made to the methodological design throughout the study.

Methodological design was based on the determinations of CONSORT Statement, 2010 [18].

2.3. Maximal static inspiratory pressure

Inspiratory muscle function testing was performed using a pressure transducer (MVD-300, Globalmed, Porto Alegre, Brazil), connected to a system with two unidirectional valves (DHD Inspiratory Muscle Trainer, Chicago, Illinois). PImax was determined in deep inspiration from residual volume against an occluded airway with a minor air leak (2 mm). The highest pressure of six measurements (with less than 5% difference) was used to define PImax. The measurements were performed before and after the protocol by a blinded investigator, and weekly during treatment.

2.4. Ambulatory blood pressure monitoring (ABPM)

To assess changes in arterial blood pressure following the intervention, ABPM was measured by a DynaMAP® monitor (Cardios, São Paulo, Brazil), validated according to international standards of the British Hypertension Society [19] and American Association for the Advancement of Medical Instrumentation (AAMI) [20]. The monitor was programmed to take BP every 15 min during the day and every 30 min at night for 24 h, with a properly sized cuff positioned in the non-dominant arm. Each participant received verbal and written instructions on the monitoring procedure and a diary to record sleep periods, posture, activity status, medication use, and symptoms. A contact number was provided for subjects to ask for advice and instructions or report any technical difficulty during the monitoring period. The exam was considered satisfactory when at least 85% of the 24 hour measurements were assessed.

2.5. Heart rate variability (HRV)

Acquisition of the electrocardiogram signal was performed immediately before and after the interventions. Measurements were taken with the subject resting comfortably in supine position, head elevation of 30°, knees resting on a wedge and controlled breathing. The breathing control was conducted by musical sounds in which the respiration rate was about 12 breaths/min (I:E = 2:3). For the analysis of the heart rate variability, temporal series of RR intervals, obtained by the continuous ECG signal (sample rate — 1 kHz) registered by a Biopac MP150 system (Biopac, California, USA), were interpolated and later submitted to spectral analysis through an auto-regressive model developed in Matlab language (Matlab 6.0, Mathworks Inc., USA). The spectral analysis of a selected time series of respiratory signal was done using software capable of this type of analysis [21], allowing for the preliminary processing of the registered signals and evaluation of all the needed parameters obtained by the self-regressive model. The temporal and/or frequency spectra of each subject were related to each other, and scheduled to be evaluated quantitatively considering the values of HRV and the relation between the power of the components LF and HF or sympathetic–vagal balance (LF/HF). The outcome variable consisted on the analysis of HRV, performed by an individual blinded to subject group assignment.

2.6. Cardiopulmonary exercise testing

Maximal functional capacity was evaluated with an incremental exercise test, with simultaneous measurement of respiratory expired gas analysis, on a cycloergometer (Inbrasport, Porto Alegre, Brazil). A ramp protocol was employed with a constant speed of 60 rpm (rotations per minute), starting load of 25 W and increments each 2 min of 15 or 25 W, depending on patients physical condition, to reach volitional fatigue at approximately 10 min. Twelve-lead electrocardiographic tracings were obtained beat-to-beat (Inbramed APEX 2000, Porto Alegre, Brazil). Blood pressure was measured every 30 s with a standard cuff sphygmomanometer. Metabolic and ventilatory variables were measured during and after exercise by 20-s mean aliquots, using a computer-aided gas analyzer (VO2max, Inbrasport) that was calibrated prior to each test. During the test, we analyzed minute ventilation (V̇E), oxygen consumption (VO2), carbon dioxide production (VCO2), respiratory exchange ratio, (VCO2/VO2) and ventilatory equivalents for oxygen (VE/VO2) and carbon dioxide (VE/VCO2). Based on this data, the maximal oxygen consumption (VO2max) was determined, as well as the first (L1) and second (L2) ventilatory thresholds.

2.7. Statistical analysis

Data were analyzed by the Statistical Package for Social Sciences (version 10.0, SPSS, Chicago, Illinois) and tested with the Kolmogorov–Smirnov for normality. All the variables fulfilled normality criteria. Descriptive data are presented as mean±SD. Baseline and blood pressure data were compared by the Student t test for continuous variables or by the Fisher exact test for categorical variables. Heart rate variability components and PImax were analyzed by two-way analysis of variance for repeated measures (ANOVA), and post-hoc analysis was conducted by the Neuman–Keuls test. A P-value<0.05 was considered statistically significant for all tests.

3. Results

3.1. Baseline characteristics

From July 2009 to September 2010, 168 patients with essential hypertension were screened for the study. Out of those, 149 patients did not meet the inclusion or met one or more of the exclusion criteria, and so, 19 patients were randomized. For the 9 patients allocated in the IMT group, 1 had a new heart failure diagnosis during the protocol and 1 had an alteration in pharmacologic management. Therefore, 13 patients completed the protocol, 6 patients in the IMT group and 7 patients in the P-IMT group. A flow diagram of included, excluded and the final number of participants is illustrated in Fig. 1. Clinical characteristics for both groups, baseline scores, including diastolic and systolic BP, heart rate variability and PImax, were comparable between the two groups (Table 1).

3.2. Inspiratory muscle strength

There was a significant increase in PImax in IMT group (82.7±28.8 vs 121.5±21.8 cmH2O, P<0.001 for time effect and P=0.003 for interaction effect). Conversely, the P-IMT group did not show any change in respiratory muscle strength following treatment (93.3±25.3 vs 106.14±25.3 cmH2O, P>0.05) (Fig. 2). The IMT induced improvement in PImax was apparent after the 5 week of training and reached a 47% increase after 8 weeks.
3.3. Blood pressure

There was a decrease of both systolic (133.2±9.9 vs 125.2±13.0 mm Hg, \(P=0.02\)) and diastolic (80.7±12.3 vs 75.2±1.0 mm Hg, \(P=0.02\)) blood pressure in the IMT group after training (Fig. 3A and B). Analyzing daytime and nighttime measures separately, we found a reduction of systolic (136.8±12.2 vs 127.6±14.2 mm Hg, \(P=0.008\)) and diastolic (83.3±13.1 vs 77.2±12.2 mm Hg, \(P=0.01\)) daytime blood pressures in the IMT group (Fig. 3C and D). However, no changes were found in both nighttime systolic (\(P=0.16\)) and diastolic (\(P=0.14\)) blood pressure in the IMT group. There was no change in blood pressure in the P-IMT group.

3.4. Heart rate variability

The high frequency component (HF) increased in the IMT group post training (75.5±14.6 vs 84.7±7.5 n.u.; \(P=0.028\)), while it did not change in the P-IMT group (60.2±24.8 vs 53.5±17.0 n.u.; \(P=0.37\)). Comparing the effect between groups, IMT was favorable in relation to placebo (\(P=0.009\)) for this component of heart rate variability analysis. Additionally, there was a reduction in the low frequency component (LF) in the IMT group (34.6±20.3 vs 12.8±6.6 n.u.; \(P=0.005\)) but not in the P-IMT group (39.7±24.8 vs 46.5±17.0; \(P=0.38\)). Further, analyzing the results pertaining to the low frequency

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**Table 1**

Baseline characteristics of patients randomized to P-IMT or IMT.

<table>
<thead>
<tr>
<th></th>
<th>IMT (n=6)</th>
<th>P-IMT (n=7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (male/female)</td>
<td>3/3</td>
<td>2/5</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>61.8±11.3</td>
<td>52.1±8.8</td>
</tr>
<tr>
<td>Body mass index (Kg/m^2)</td>
<td>26.8±2.5</td>
<td>27.8±1.7</td>
</tr>
<tr>
<td>PImax (cmH2O)</td>
<td>93±29.7</td>
<td>94.3±24.6</td>
</tr>
<tr>
<td>SBP</td>
<td>133.1±9.8</td>
<td>130±6.4</td>
</tr>
<tr>
<td>DBP</td>
<td>80.6±12.3</td>
<td>86.4±9.3</td>
</tr>
<tr>
<td>Diuretics (%)</td>
<td>83.3</td>
<td>71.4</td>
</tr>
<tr>
<td>Beta blockers</td>
<td>66.7</td>
<td>57.4</td>
</tr>
<tr>
<td>Calcium antagonists</td>
<td>16.7</td>
<td>42.7</td>
</tr>
<tr>
<td>ACE inhibitors</td>
<td>83.3</td>
<td>71.4</td>
</tr>
<tr>
<td>Time of diagnosis (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 to 5 years</td>
<td>33.3</td>
<td>28.6</td>
</tr>
<tr>
<td>5 to 10 years</td>
<td>16.7</td>
<td>14.4</td>
</tr>
<tr>
<td>&gt; 10 years</td>
<td>50.0</td>
<td>57.1</td>
</tr>
</tbody>
</table>

Values expressed as mean±standard deviation. IMT: inspiratory muscle training; P-IMT: placebo-inspiratory muscle training; PImax: maximal static inspiratory pressure; SBP: Systolic blood pressure; DBP: Diastolic Blood Pressure.
component between groups, the effect of training was better in IMT compared to P-IMT ($P=0.01$). There was also a difference comparing IMT to P-IMT after training for the fLF component ($P=0.013$), demonstrating favorable modifications in sympathetic discharge in IMT group. Results of the spectral analysis are shown in Table 2 and Fig. 4.

### 3.5. Cardiopulmonary exercise testing

Comparison of the peak respiratory exchange revealed no significant differences between the baseline and post training CPX in either the IMT ($1.1±0.04$ vs. $1.0±0.06$, $P>0.05$) or P-IMT ($1.1±0.1$ vs. $1.1±0.06$, $P>0.05$) group, indicating comparable effort. The same was observed for peak systolic blood pressure in the IMT ($183.3±24.2$ vs. $186.7±25.0$ mm Hg, $P>0.05$) and P-IMT ($208.3±29.1$ vs. $197.5±30.9$ mm Hg, $P>0.05$) groups. In relation to oxygen uptake, peak VO$_2$ was not significantly different after the protocol in either the IMT ($19.0±3.8$ vs. $23.9±13.6$ mlO$_2$·kg$^{-1}$·min$^{-1}$, $P>0.05$) or P-IMT ($17.2±3.2$ vs. $18.8±6.8$ mlO$_2$·kg$^{-1}$·min$^{-1}$, $P>0.05$) group.

### 4. Discussion

To our knowledge, this is the first controlled blinded trial evaluating the effects of IMT in patients with essential hypertension. In this study, we demonstrated that a home-based, eight-week IMT program reduced daytime systolic ($−7.9$ mm Hg) and diastolic ($−5.5$ mm Hg) blood pressure and improved cardiovascular autonomic control, which is related to cardiovascular risk factors, by reducing sympathetic modulation (LF n.u. component) and increasing parasympathetic modulation (HF n.u. component), in patients with essential hypertension. The efficacy of IMT was compared to a placebo intervention, and all outcomes were blindly evaluated. As none of the patients had never done IMT before, according to previous interview, and the practice of IMT with low load has been studied before with no side effects [22], we considered that all participants were blinded according to both load and the placebo effect. Compliance was evaluated by the use of a training diary, where all participants documented their daily practice and also by weekly interviews conducted by the same physician. Thus we are highly confident subjects were compliant with the home-based intervention.

#### 4.1. Inspiratory muscle training

Many studies have demonstrated a clinically important gain in inspiratory muscle strength and endurance after IMT, especially in cohorts diagnosed with chronic heart failure and chronic obstructive pulmonary disease [16, 23–25]. In the present study, patients in the IMT group had a 47% increase in inspiratory muscle strength after 25.0 mm Hg, $P>0.05$) and P-IMT ($208.3±29.1$ vs. $197.5±30.9$ mm Hg, $P>0.05$) groups. In relation to oxygen uptake, peak VO$_2$ was not significantly different after the protocol in either the IMT ($19.0±3.8$ vs. $23.9±13.6$ mlO$_2$·kg$^{-1}$·min$^{-1}$, $P>0.05$) or P-IMT ($17.2±3.2$ vs. $18.8±6.8$ mlO$_2$·kg$^{-1}$·min$^{-1}$, $P>0.05$) group.

### Table 2

<table>
<thead>
<tr>
<th></th>
<th>IMT (n=6)</th>
<th>P-IMT (n=7)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HR (bpm)</strong></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>HRV components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>var (ms$^2$)</td>
<td>0.6±0.3</td>
<td>0.7±0.5</td>
</tr>
<tr>
<td>LF (Hz)</td>
<td>0.06±0.02</td>
<td>0.08±0.03</td>
</tr>
<tr>
<td>fHF (Hz)</td>
<td>0.2±0.003</td>
<td>0.2±0.01</td>
</tr>
<tr>
<td>HF (ms$^2$)</td>
<td>375.6±257.9</td>
<td>563.7±245.7</td>
</tr>
<tr>
<td>HF (n.u.)</td>
<td>75.5±14.6</td>
<td>84.7±7.5$^\dagger$</td>
</tr>
<tr>
<td>LF/HF</td>
<td>0.7±0.7</td>
<td>0.16±0.09</td>
</tr>
</tbody>
</table>

The values are expressed as mean±SD. Two-way ANOVA for repeated measures. Heart Rate = HR; HRV = Heart rate variability; VLF = very low frequency component; LF = low frequency component; HF = high frequency component. $^\ast$ $P<0.05$ for training and interaction effects. $^\dagger$ $P<0.05$ for group effect.
an 8 week training program. Comparatively, in a previous study of Dall’Ago et al [16], patients with chronic heart failure demonstrated an increase of 115% in PImax after 12 weeks of treatment. While improvements in both trials were statistically significant compared to baseline, the dramatically greater improvement in patients with heart failure is likely due to the fact that patients diagnosed with this chronic condition have far worse respiratory muscle function at baseline (i.e. greater potential for improvement).

Thus, IMT improved BP and autonomic tone without improving aerobic capacity in the current investigation. This is different from what has been found in heart failure [16, 22]. A hypothesized reason for this lack of change in aerobic capacity in the present study is that subjects were far less functionally disabled compared to subjects diagnosed with heart failure. Therefore, IMT was not enough to improve total body aerobic function. Patients with chronic heart failure have a much lower total body aerobic capacity and thus IMT appears to be a sufficient stimulus to induce a significant increase in peak VO2. Even so, the other positive physiologic adaptations reported in the current study potentially justify the use of IMT in patients with essential hypertension and well preserved aerobic function.

4.2. Effects of IMT on blood pressure

The current study demonstrated that an 8 week IMT program with a 30% PImax load was able to reduce daytime arterial blood pressure. Other studies have reported similar results with the practice of breathing exercises, without load [7, 10–11, 13, 15] in cohorts with similar characteristics to the one examined in the current analysis. Respiratory modulation is related to cardiovascular modulation and it plays a pivotal role in blood pressure control. This important interaction is noticed by the generalized alteration that occurs in cardiovascular control in conjunction with respiratory pattern modifications. This relationship is likely related to baroreceptor and chemoreceptor sensitivity [26] interaction and its influence on the mechanisms of blood pressure control. In a certain manner, reductions of blood pressure are more evidenced with the practice of slow breathing [10–13] when compared to a faster respiratory pattern [15]. However, subjects included in the present study did not control respiratory rate during IMT sessions or during blood pressure assessment. Therefore, the present results suggest that modifications in blood pressure level are at least in part, related to the inspiratory load used during IMT (represented by the use of inspiratory load) and thus not only associated with alterations in the respiratory pattern as previously reported [7, 12, 15, 27–28].

The mean reduction in systolic and diastolic blood pressure found in the current study was higher than the found by others examining the effects of slow breathing exercise [7–8, 29]. However, the majority of the studies that report changes in BP after breathing exercises did not perform ABPM, as we did. Comparing our results with those presented by Modesti et al [8], when the effects of slow breathing were evaluated with ABPM, our data demonstrated a better outcome in both systolic (−7.9 vs −5.4 mm Hg) and diastolic (−5.5 vs −2.4 mm Hg) BP reduction. This comparison suggests that inspiratory load promotes more beneficial effects on blood pressure control in hypertensive subjects compared to breathing exercises.

4.3. Effects of IMT on autonomic cardiovascular control

Slow breathing leads to RR fluctuations, which are related to blood pressure changes mediated by respiratory modulation and with enhanced baroreflex activity [11]. We did not evaluate baroreflex activity in the current study, although it is well established that both baroreflex [11, 28] and chemoreflex [27] sensitivity among the mechanisms involved in sympathetic modulation. So, it seems reasonable to hypothesize that besides the reduction of sympathetic activity that we have found here, there would also be some positive effect on baroreflex and/or chemoreflex sensitivity.

Moreover, induction of inspiratory muscle fatigue in healthy humans results in an increase of muscle sympathetic nerve activity, heart rate and mean arterial pressure [14], and a gradual reduction in arterial blood flow to the resting limbs [30]. Therefore, experimental research shows that a fatigueing diaphragm leads to increased sympathetic outflow [31]. These previous observations collectively suggest that inspiratory muscle fatigue generates an increase in the metaboreflex, which increases peripheral sympathetic activity. Thus, enhancement of respiratory muscle function by IMT may increase fatigue resistance and lessen sympathetic outflow.

Fig. 4. An example of spectrum of Heart Rate Variability (HRV). The graphic shows power spectrum of the RR interval series: the frequency, expressed in Hz, is reported on the x-axis, while the power spectral density of HRV, expressed in s²/Hz is reported on the y-axis. Dashed line represents P-IMT group and solid line represents IMT group. The pie graph on the right represents the Total Heart Rate Variability divided into the two components, in percentages of total, LF [P-IMT (gray) and IMT (black)] and HF (white). A: spectrum of HRV before treatment. B: spectrum of HRV after treatment.
Although the RR variability was not different, it shows a behavior close to that demonstrated by others (1998), i.e. IMT decreases the RR interval and P-IMT increases the RR interval.

We also observed an increased parasympathetic modulation after IMT compared to P-IMT. Although previous research in this area is limited, the current findings agree with other studies regarding the effects of breathing exercises in patients with hypertension. It is known that respiratory patterns change autonomic cardiovascular modulation, especially with respect to the HF component of HRV [32]. Comparing the effects of slow and fast breathing on sympathetic/parasympathetic modulation in hypertensive subjects, Mourya et al [15] reported an improvement in parasympathetic activity after slow breathing.

4.4. Limitations

The present study does have limitations that warrant discussion. Firstly, sympathetic/parasympathetic system evaluation is different among the studies we found; i.e. the method we have chosen is not a direct measurement of autonomic modulation compared to assessment of muscle sympathetic nerve activity used by others [14]. These methodological differences may complicate the comparison of results from different investigations in this area. Secondly, we did not perform baroreflex and/or chemoreflex evaluation, which could be used to further elucidate the mechanism for blood pressure reductions through IMT. Moreover, we did not evaluate inspiratory muscle endurance; this measurement could demonstrate training effects with more accuracy compared to quantification of inspiratory muscle strength alone. Finally, even with a small sample size, our data showed a power of 95%, analyzing the effects of IMT on autonomic cardiovascular control between groups.

In conclusion, regarding the effects of IMT on blood pressure control in patients with essential hypertension, we found a decrease of sympathetic and an increase of parasympathetic modulation. In addition, daytime systolic and diastolic blood pressure levels showed improvements only in the IMT group. These data support the assertion that IMT is beneficial in the treatment of patients with controlled hypertension. Moreover, our results suggest for the first time that a home-based, eight-week IMT program provides important effects on cardiopulmonary interaction, resulting in improvement in cardiovascular autonomic control and blood pressure levels. The results of the current study highlight the importance of continuing research in this area to better elucidate the effects of IMT on this and other patient populations and ultimately broaden appropriate clinical application.

4.5. Perspectives

IMT may be a possible non pharmacological treatment option for patients with hypertension. In addition to positive physiologic adaptations, benefits of this approach include cost efficiency, home-based therapy, and minimal exertional requirements. Moreover, we intend to investigate other effects in the future, such as a reduction in the need for pharmacological treatment, especially beta-blocker use, and the impact in the quality of life in these patients.

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