International Journal of Yoga, Physiotherapy and Physical Education
www.sportsjournal.in
ISSN: 2456-5067
Received: 19-07-2026, Accepted: 18-08-2026, Published: 02-09-2026
Volume 11, Issue 3, 2026, Page No. 58-62

Effect of HRV-guided autonomic modulation technique and isometric handgrip training on blood pressure and kinesiophobia in valve replacement surgery

Saranya Y[1], Dr. Manoj Abraham M[2], Santhiya S[3*], Gayathri M[3]

[1] Professor/ Vice Principal, KG College of Physiotherapy, Affiliated to the Tamil Nadu Dr. M.G.R. Medical University, Chennai, Tamil Nadu, India

[2] Professor/ Principal, KG College of Physiotherapy, Affiliated to the Tamil Nadu Dr. M.G.R. Medical University, Chennai, Tamil Nadu, India

[3] KG College of Physiotherapy, Affiliated to the Tamil Nadu Dr. M.G.R. Medical University, Chennai, Tamil Nadu, India

Corresponding Author: Santhiya S

DOI: https://doi.org/10.66856/ijyppe.2026.11.3.11063

Abstract

Background: Valve replacement surgery is a restores cardiac function, but many patients continue to experience persistent hypertension and autonomic imbalance during recovery. Additionally, fear of movement (kinesiophobia) may limit rehabilitation patients. Heart rate variability (HRV) guided slow breathing increase autonomic balance, and isometric handgrip reduces blood pressure. This study explores the combined effect of this intervention on physiological and psychological recovery.

Aim: Evaluate the effect of HRV-guided autonomic modulation technique combined with isometric handgrip training on blood pressure and kinesiophobia in hypertensive patients after valve replacement surgery.

Methods: A Quasi experimental pretest and posttest study was conducted among 30 valve replacement patients, 3 to 12 weeks of post-surgery. Patients received slow breathing (6 breaths/ minutes for 15 minutes) followed by isometric handgrip training at 30% maximum voluntary contraction (MVC), calculated a: training intensity=0.30×MVC. The intervention was performed five sessions per week for six weeks. Outcome measures included systolic and diastolic blood pressure and Tampa scale of kinesiophobia (TSK).

Results: The combination of HRV guided autonomic modulation and isometric handgrip training significant reductions were observed in systolic and diastolic blood pressure and TSK score. (p=0.05)

Conclusions: The combined effect of HRV guided autonomic modulation technique and isometric handgrip regulates blood pressure control, and reduces kinesiophobia.

Keywords: Heart rate variability, autonomic modulation technique, isometric handgrip training, valve replacement patients, blood pressure and kinesiophobia

Introduction

Hypertension continues to be one of the most significant and preventable contributors to cardiovascular morbidity and mortality worldwide [1]. It affects more than one billion individuals globally and remains a major public health burden, particularly in developing countries [2]. Chronic elevation of blood pressure imposes continuous hemodynamic stress on the cardiovascular system, leading to structural remodeling such as left ventricular hypertrophy, endothelial dysfunction, arterial stiffness, and progressive degenerative changes in cardiac valves [3, 5].

Over time, sustained pressure overload accelerates calcific and fibrotic changes in the aortic and mitral valves, contributing to the development of valvular heart disease (VHD) [6]. Epidemiological data suggest that VHD affects approximately 2–3% of the general population, with prevalence increasing substantially with advancing age [7]. In advanced stages, when valvular dysfunction significantly compromises cardiac output and systemic circulation, valve replacement surgery becomes the definitive therapeutic intervention [8].

Although surgical valve replacement corrects the mechanical abnormality, it does not fully restore physiological homeostasis. Many patients continue to demonstrate elevated blood pressure, impaired vascular compliance, and persistent autonomic dysregulation postoperatively [9, 10]. Autonomic imbalance—characterized by increased sympathetic dominance and reduced parasympathetic (vagal) activity—plays a central role in the pathophysiology of hypertension and its long-term complications [11]. Reduced heart rate variability (HRV), a non-invasive marker of autonomic dysfunction, has been strongly associated with increased cardiovascular risk and adverse outcomes [12, 13].

In the postoperative cardiac population, impaired vagal modulation and reduced baroreflex sensitivity may delay recovery and contribute to persistent hemodynamic instability [14]. Therefore, targeting autonomic regulation has emerged as an important component of modern cardiac rehabilitation.

Heart rate variability-guided autonomic modulation, particularly through slow-paced resonance-frequency breathing (approximately six breaths per minute), has demonstrated promising effects in improving sympathovagal balance [15, 16]. Controlled breathing enhances vagal tone, optimizes baroreflex sensitivity, reduces sympathetic overactivity, and subsequently lowers resting blood pressure [17, 18]. Recent systematic reviews have further confirmed the positive effects of slow breathing interventions on hemodynamic parameters in hypertensive individuals [19, 20].

Similarly, isometric handgrip training has gained recognition as an effective and practical non-pharmacological intervention for blood pressure management [21]. Repeated low-to-moderate intensity isometric contractions (typically 30% of maximal voluntary contraction) induce favorable vascular adaptations, improve endothelial function, enhance nitric oxide bioavailability, and reduce peripheral vascular resistance [22, 24]. Randomized controlled trials have consistently demonstrated significant reductions in systolic and diastolic blood pressure following structured isometric handgrip training programs [25, 27]. Due to its simplicity, safety, and minimal equipment requirement, this intervention is particularly suitable for integration into cardiac rehabilitation settings.

Beyond physiological recovery, psychological readiness plays a crucial role in postoperative outcomes. Kinesiophobia, defined as an excessive and irrational fear of movement due to perceived vulnerability to injury or adverse events, has been increasingly recognized in cardiac populations [28]. Following valve replacement surgery, patients may avoid physical exertion due to anxiety about provoking cardiac symptoms, thereby limiting engagement in rehabilitation programs. According to the fear-avoidance model, persistent fear of movement may lead to avoidance behavior, physical deconditioning, and delayed functional recovery [29, 30].

Comprehensive cardiac rehabilitation should therefore address both physiological and psychological components of recovery [31]. While HRV-guided breathing and isometric handgrip training have independently demonstrated efficacy in hypertensive populations, limited research has investigated their combined effect on both cardiovascular parameters and kinesiophobia in hypertensive patients after valve replacement surgery [32].

An integrated approach targeting autonomic modulation and fear reduction may enhance hemodynamic stability, improve psychological confidence, and promote adherence to rehabilitation programs. Exploring this combined intervention may contribute to the development of more holistic, patient-centered cardiac rehabilitation strategies.

Therefore, the present study aims to investigate the effect of heart rate variability-guided autonomic modulation combined with isometric handgrip training on blood pressure and kinesiophobia in hypertensive patients following valve replacement surgery.

Methodology

Study Design

This study was conducted as a quasi-experimental study to evaluate the effects of heart rate variability (HRV) breathing exercises combined with isometric handgrip training on blood pressure and kinesiophobia among individuals undergoing cardiac rehabilitation. The study was carried out in the Department of Physiotherapy/Cardiac Rehabilitation Unit of a tertiary care hospital, where participants receiving routine cardiac rehabilitation services were recruited based on predefined inclusion and exclusion criteria. Eligible participants were allocated into an experimental group and a control group to compare the outcomes of the intervention. Baseline assessments were performed prior to the intervention, and post-intervention assessments were conducted after completion of the training program. All procedures and exercise sessions were supervised by qualified physiotherapists in a controlled clinical setting to ensure participant safety and adherence to the protocol. The study, including participant recruitment, intervention, and data collection, was conducted over a period of 6 weeks

Sample Size

A total of 25 participants were included in this study. The sample size was calculated using a 95% confidence level based on previous similar studies. Participants were recruited from the cardiac rehabilitation unit using a convenience sampling technique according to the inclusion and exclusion criteria. As this was a single-group quasi-experimental study, all participants received the intervention, and outcome measures were assessed pre-test and post-test the intervention program.

Study Participants

Participants were included in the study if they were individuals diagnosed with cardiovascular disease and enrolled in a cardiac rehabilitation program, aged between 30 and 65 years, medically stable to participate in exercise training as approved by a physician, and willing to provide written informed consent. Both male and female participants were considered eligible. Participants were excluded if they had uncontrolled hypertension or unstable cardiovascular conditions, severe musculoskeletal disorders affecting the upper limb that could limit handgrip exercise, neurological conditions interfering with breathing or movement, cognitive impairment affecting their ability to follow instructions, or if they were participating in other structured exercise programs during the study period.

Intervention Protocol

1. HRV-Guided Autonomic Modulation

- Slow-paced breathing at ~6 breaths/minute
- Inhalation: 5 seconds
- Exhalation: 5 seconds
- Duration: 15 minutes/session
- Frequency: 5 days/week
- Total duration: 6 weeks

(Participants were guided using breathing pacing instructions; HRV was monitored using pulse rate variability.)

2. Isometric Handgrip Training

- Intensity: 30% of Maximum Voluntary Contraction (MVC)
- 4 sets of 2-minute sustained contraction
- 1-minute rest between sets
- Frequency: 3 days/week
- Duration: 6 weeks

Performed using handgrip dynamometer

Outcome Measures

Primary Outcome

Blood Pressure (SBP & DBP) - Measured using calibrated digital sphygmomanometer in seated position after 5 minutes rest.

Secondary Outcome

Kinesiophobia - Assessed using the Tampa Scale of Kinesiophobia (TSK).

Procedure

Eligible participants were assessed for baseline blood pressure and kinesiophobia scores. Following this, participants underwent the combined intervention protocol for six weeks under physiotherapy supervision. Post-intervention assessments were performed using the same outcome measures.

Statistical Analysis

Data were analyzed using paired sample t-test.
Mean and standard deviation were calculated for all outcome variables.
Significance level was set at $p < 0.05$.
Statistical analysis was performed using manual calculation method.

Results

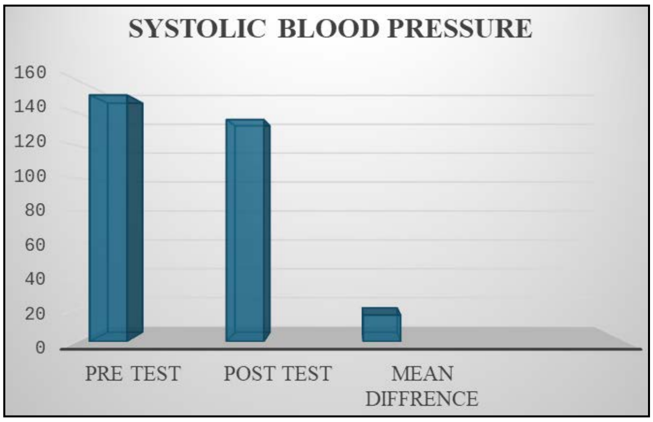
A total of 25 hypertensive patients who underwent valve replacement surgery completed the 6-week intervention.

1. BLOOD PRESSURE

There was a statistically significant reduction in systolic and diastolic blood pressure following the intervention.

Table 1: Systolic Blood Pressure

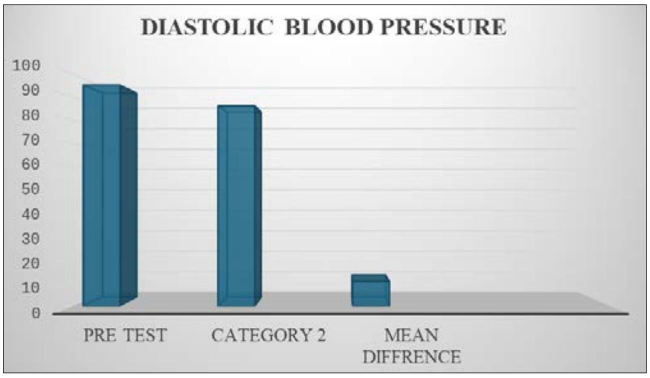
Variables	Pre-test	Post-test	Mean difference	T	P
Systolic Blood Pressure (SBP)	152.4 ± 8.6 mmHg	136.2 ± 7.9 mmHg	16.2 mmHg	9.84	< 0.001



Graph 1

Table 2: Diastolic Blood Pressure

Variables	Pre-test	Post-test	Mean difference	T	P
Diastolic Blood Pressure (DBP)	94.8 ± 5.7 mmHg	84.3 ± 5.2 mmHg	10.5 mmHg	8.72	< 0.001



Graph 2

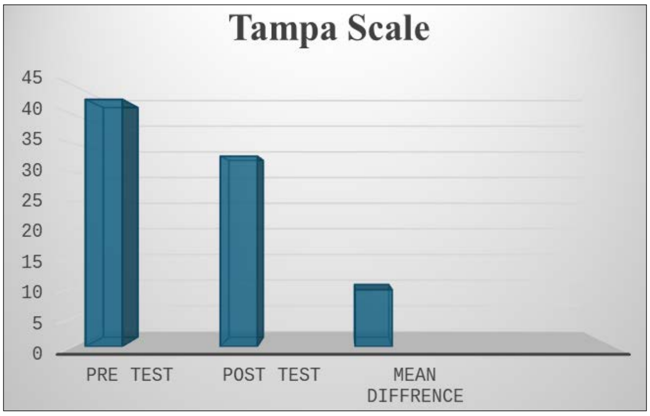
These graph shows a significant reduction in the blood pressure following HRV-guided autonomic modulation combined with isometric handgrip training.

2. Kinesiophobia (Tampa Scale of Kinesiophobia – Tsk)

A significant reduction in kinesiophobia scores was observed post-intervention.

Table 3: Tampa Scale of Kinesiophobia

Variables	Pre-test	Post-test	Mean difference	T	P
TSK Score	42.6 ± 4.3	: 32.8 ± 3.9	9.8 points	= 10.12	< 0.001



Graph 3

This graph shows a significant decrease in fear of movement after the intervention period

Discussion

The current research sought to look into if mixing HRV-guided autonomic modification with static handgrip workouts could better blood pressure and lessen kinesiophobia in hypertensive people following valve replacement operations. The outcomes demonstrated notable drops in both systolic and diastolic blood pressure, along with a clear lessening of movement fear following six weeks of therapy. A primary reason for the lower blood pressure might be better autonomic equilibrium. Hypertensive patients, especially after heart surgery, frequently show sympathetic overdrive and diminished vagal responsiveness. Lehrer and Gevirtz (2014) clarified that slow breathing elevates vagal action and boosts baroreflex responsiveness, which directly aids in improved blood pressure control. Likewise, Bernardi et al. (2001) illustrated that managed slow breathing can meaningfully decrease blood pressure through modifying autonomic function. The enhancements noted in our investigation concur with these physiological processes. Aside from the breathing practice, isometric handgrip exercise probably held a vital function. Carlson et al. (2014), in their broad review, noted that isometric exercise training substantially lowers resting blood pressure among people with hypertension. Cornelissen and Fagard (2011) further pointed out that resistance style training enhances vessel flexibility and lessens outward resistance.

The blood pressure decrease seen in this present study matches these earlier reports, implying that changes in blood vessels and improved endothelial performance might have influenced the results. An additional significant discovery from this investigation was the lowering of kinesiophobia. Following valve replacement surgery, individuals frequently develop a dread of movement from worries about heart stress or problems. Vlaeyen et al. (1995) detailed how movement fear can result in avoidance actions and slower functional recovery.

Through presenting step by step, monitored, and secure exercise exposure, this current treatment might have assisted patients in recovering belief in their physical capabilities. This mental easing probably added to the noted drop in Tampa Scale results. What makes this research clinically important is the combined method. HRV-guided breathing focused on autonomic regulation while isometric handgrip training enhanced vascular function, and both addressed physical and mental parts of getting better.

Current cardiac rehabilitation stresses this unified framework, which Piepoli et al. (2016) also backed up, stressing the need to mix physical and behavioral plans in cardiovascular recovery. In general, the results indicate that mixing autonomic modulation methods with planned isometric exercise might present a secure, straightforward, and affordable approach to boost cardiovascular steadiness and lower movement anxiety among hypertensive patients after valve replacement procedures.

Conclusion

The present study concludes that a combination of heart rate variability-guided autonomic modulation techniques and isometric handgrip training may be a useful physiotherapeutic approach for individuals with hypertension following valve replacement surgery. The intervention focuses on both autonomic regulation and controlled muscular activity, which may contribute to better blood pressure control and improved psychological confidence during physical activity. In addition to its potential cardiovascular benefits, the approach may help reduce kinesiophobia, thereby encouraging patients to participate more actively in rehabilitation and daily functional activities.

The findings support the integration of individualized autonomic modulation strategies with appropriately prescribed isometric exercise as part of comprehensive cardiac rehabilitation after valve replacement surgery. However, further studies involving larger sample sizes, longer follow-up periods, and comparison with conventional cardiac rehabilitation approaches are recommended to establish the long-term effectiveness and clinical applicability of this combined intervention.

Acknowledgements

I would like to express my sincere gratitude to my guide and co-guide for their continuous support, valuable guidance, and constructive feedback throughout the completion of this study. Their expertise and encouragement played a vital role in shaping this research work.

I extend my heartfelt thanks to the Head of the Department and faculty members of the Department of Cardiopulmonary Physiotherapy for providing the necessary facilities and academic support.

I am deeply thankful to the hospital administration and medical team for permitting data collection and facilitating the smooth conduct of this study.

Special appreciation goes to all the participants who willingly contributed their time and effort to be part of this research.

Finally, I would like to thank my family and friends for their constant motivation and support.

References

1. Lehrer PM, Gevirtz R. Heart rate variability biofeedback: How and why does it work? Front Psychol,2014:5:756.
2. Bernardi L, Porta C, Spicuzza L, Bellwon J, Spadacini G, Frey AW, et al. Slow breathing increases arterial baroreflex sensitivity in patients with chronic heart failure. Circulation,2002:105(2):143-5.
3. Shaffer F, McCraty R, Zerr CL. A healthy heart is not a metronome: an integrative review of heart rate variability. Front Psychol,2014:5:1040.
4. Task Force of the European Society of Cardiology. Heart rate variability: standards of measurement, physiological interpretation and clinical use. Circulation,1996:93(5):1043-65.
5. Malik M, Camm AJ. Heart rate variability. Clin Cardiol,1990:13(8):570-6.
6. Thayer JF, Lane RD. The role of vagal function in the risk for cardiovascular disease. Biol Psychol,2007:74(2):224-42.
7. Lehrer PM, Vaschillo E, Vaschillo B. Resonant frequency biofeedback training to increase cardiac variability. Appl Psychophysiol Biofeedback,2000:25(3):177-91.
8. Brown RP, Gerbarg PL. Sudarshan Kriya yogic breathing in treatment of stress, anxiety and depression. J Altern Complement Med,2005:11(4):711-7.
9. Joseph CN, Porta C, Casucci G, Casiraghi N, Maffeis M, Rossi M, et al. Slow breathing improves arterial baroreflex sensitivity and decreases blood pressure. Hypertension,2005:46(4):714-8.
10. Pal GK, Velkumary S, Madanmohan. Effect of short-term practice of breathing exercises on autonomic functions. Indian J Med Res,2004:120(2):115-21.
11. McCraty R, Atkinson M, Tomasino D. Impact of a workplace stress reduction program on blood pressure and emotional health. J Altern Complement Med,2003:9(3):355-69.
12. Carlson DJ, Dieberg G, Hess NC, Millar PJ, Smart NA. Isometric exercise training for blood pressure management: A systematic review and meta-analysis. Mayo Clin Proc,2014:89(3):327-34.
13. Cornelissen VA, Fagard RH. Effects of resistance training on blood pressure. Hypertension,2011:58(5):950-8.
14. Wiles JD, Goldring N, Coleman D. Home-based isometric exercise training to reduce resting blood pressure. Eur J Appl Physiol,2010:108(6):1265-73.
15. Millar PJ, McGowan CL, Cornelissen VA, Araujo CG, Swaine IL. Evidence for the role of isometric exercise training in reducing blood pressure. Hypertens Res,2014:37(9):781-9.
16. Inder JD, Carlson DJ, Dieberg G, McFarlane JR, Hess NC, Smart NA. Isometric exercise training for blood pressure reduction. Blood Press Monit,2016:21(2):64-70.
17. Taylor RS, Brown A, Ebrahim S, Jolliffe J, Noorani H, Rees K, et al. Exercise-based rehabilitation for patients with coronary heart disease. Am J Med,2004:116(10):682-92.
18. Anderson L, Oldridge N, Thompson DR, Zwisler AD, Rees K, Martin N, et al. Exercise-based cardiac rehabilitation for coronary heart disease. J Am Coll Cardiol,2016:67(1):1-12.

19. Piepoli MF, Corrà U, Adamopoulos S, Benzer W, Bjarnason-Wehrens B, Cupples M, et al. Secondary prevention through cardiac rehabilitation. Eur Heart J,2016:37(29):2315-81.
20. Lavie CJ, Arena R, Swift DL, Johannsen NM, Sui X, Lee DC, et al. Exercise and cardiovascular disease prevention. J Am Coll Cardiol,2015:65(19):2098-105.
21. Dishman RK, Heath GW, Lee IM. Physical activity epidemiology. 2nd ed. Champaign: Human Kinetics, 2013.
22. American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription. 10th ed. Philadelphia: Lippincott Williams & Wilkins, 2018.
23. Fletcher GF, Ades PA, Kligfield P, Arena R, Balady GJ, Bittner VA, et al. Exercise standards for testing and training. Circulation,2013:128(8):873-934.
24. Barlow DH. Anxiety and its disorders. 2nd ed. New York: Guilford Press, 2002.
25. Vlaeyen JW, Kole-Snijders AM, Boeren RG, Van Eek H. Fear of movement in chronic low back pain. Pain,1995:62(3):363-72.
26. Kori SH, Miller RP, Todd DD. Kinesiophobia: a new view of chronic pain behavior. Pain Manag,1990:3:35-43.
27. Lundberg U. Stress hormones in health and illness. Psychoneuroendocrinology,2005:30(10):1017-21.
28. McEwen BS. Protective and damaging effects of stress mediators. N Engl J Med,1998:338(3):171-9.
29. Chida Y, Steptoe A. Greater cardiovascular responses to stress predict future blood pressure. Hypertension,2010:55(4):1026-32.
30. Brook RD, Appel LJ, Rubenfire M, Ogedegbe G, Bisognano JD, Elliott WJ, et al. Beyond medications and diet. Hypertension,2013:61(6):1360-83.
31. Hall JE. Guyton and Hall textbook of medical physiology. 13th ed. Philadelphia: Elsevier, 2016.
32. Ganong WF. Review of medical physiology. 26th ed. New York: McGraw Hill, 2010.
33. Sherwood L. Human physiology from cells to systems. 9th ed. Boston: Cengage Learning, 2016.
34. McArdle WD, Katch FI, Katch VL. Exercise physiology: energy, nutrition and human performance. 8th ed. Philadelphia: Lippincott Williams & Wilkins, 2015.
35. Guyton AC, Hall JE. Textbook of medical physiology. 12th ed. Philadelphia: Elsevier, 2011.
36. Arena R, Myers J, Williams MA, Gulati M, Kligfield P, Balady GJ, et al. Assessment of functional capacity in clinical practice. Circulation,2007:116(3):329-43.
37. Kiviniemi AM, Hautala AJ, Kinnunen H, Tulppo MP. Endurance training guided by HRV. Eur J Appl Physiol,2007:101(6):743-51.
38. Tulppo MP, Makikallio TH, Seppanen T, Laukkanen RT, Huikuri HV. Vagal modulation during exercise. Am J Physiol,1998:274:H424-9.
39. Sandercock GR, Bromley PD, Brodie DA. Effects of exercise on heart rate variability. Br J Sports Med,2005:39(12):884-93.
40. Carter JR, Ray CA. Sympathetic neural responses to mental stress. J Physiol,2009:587(3):749-56.
41. Smart NA, Howden R. Exercise training for blood pressure. J Hum Hypertens,2017:31(1):1-9.
42. World Health Organization. Global recommendations on physical activity for health. Geneva: WHO, 2010.