



EFFECT OF GALVANIC SKIN RESPONSE TRAINING ON BLOOD PRESSURE: A REVIEW

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ABSTRACT This review paper aims to summarise the evidence of effect of galvanic skin resistance biofeedback training on blood pressure. After assessing quality of studies, 4 articles were included in the study. Although no long term effects were measured in these studies; GSRBF seems to be more effective in reducing SBP and DBP. The goal of the treatment is not only the reduction of blood pressure but also to reduce the cost of overall direct and indirect costs for treatment of hypertension and its consequences constitute a substantial economic burden for our communities.

KEYWORDS : galvanic skin response, biofeedback, blood pressure, hypertension

INTRODUCTION

As much as 10%-15% of the world population is affected by the hypertension. Approximately, 70% of the hypertensive population has relatively mild hypertension (diastolic blood pressure between 90 and 105 mm Hg).^[1] It is one of the leading health problems in India and leads around 1.1 million deaths (uncertainty index 0.9-1.3 million) annually.^[2] It accounts for 10.8% of all deaths and 4.6% of all disability adjusted life years (DALYs).^[3]

The World Health Organization has pinpointed hypertension as one of the principal causes of premature morbidity and mortality in both developed and developing countries.^[4] Persistent hypertension is a key risk factor for coronary heart disease, stroke and other cardiovascular diseases, such as heart failure. Hypertension is important not only because of its high prevalence, but also because it is the largest single modifiable risk factor for cardiovascular disease and mortality worldwide.^[5] Furthermore, the direct and indirect costs for treatment of hypertension and its consequences constitute a substantial economic burden for our communities.^[6]

Recently, varieties of relaxation techniques are being used to reduce stress and anxiety. Biofeedback (BF) training is considered to be an effective tool in different health conditions ranging from hypertension to epilepsy. It enables the subject to control the bodily responses.^[7] Biofeedback has been applied to the treatment of mild to moderate essential hypertension. The main objective of biofeedback is to control the blood pressure (BP) and reduce the requirement of medications.^[1]

Hypertensive patients are taught these procedures to control or lower their BP. In biofeedback training, patients are connected to the instrument which provides continuous feedback regarding their BP. A visual or auditory signal is provided whenever the BP falls to a pre-specified level. In order to keep the BP low, patients are asked to reflect the thoughts they had or activity they were doing when the BP was low in order to maintain that same level. In this way, the patients learn to identify sensations that accompany reductions in BP, and after several training sessions, the patients may be able to maintain the control of their BP.^[8]

Paran et al. have found that with biofeedback assisted relaxation training there is improvement in BP and reduction in medication. While Mogra and Singh have reported that with yogic relaxation in combination with galvanic skin resistance biofeedback (GSRBF) training for 30 min for 2 months have shown improvement in both systolic blood pressure (SBP) and diastolic blood pressure (DBP).^[7]

Recent studies have shown that the risk of coronary heart disease reduces with the reduction of BP of patients with DBP as low as 90 mm Hg. Yet there is concern over the costs and hazards of putting a large proportion of the adult population on long-term antihypertensive drugs. Because of this non-pharmacological approaches to the control of hypertension are increasingly being considered.³ Several studies have shown that, in specially selected groups, relaxation techniques may be used to decrease antihypertensive medication and lower blood pressure.^[9]

METHODOLOGY

A computer-based literature search was done using the PUBMED, PUBMED CENTRAL, and GOOGLE SCHOLAR. Relevant articles with full text published in English using all possible combinations of the index terms “Galvanic skin resistance”, “galvanic skin resistance biofeedback training”, “biofeedback training”, “blood pressure” were screened and included. Editorials, Commentaries, Discussion papers, Conference abstracts, were excluded. All studies have focused on GSR biofeedback training and blood pressure. All the articles were evaluated with respect to this question. Whether galvanic skin resistance training has effect on blood pressure? After the screening through articles 4 relevant and recent articles were included in the review. The characteristics of reviewed articles are summarized in the table.

DISCUSSION AND CONCLUSION

In the present study, it can be seen that rather than simple clinic visits or self-monitoring of blood pressure, biofeedback treatment had shown consistently greater effects on blood pressure. These findings were compatible to those in the previous meta-analysis studies. Although the JNC-VI commented that “biofeedback has been studied in multiple controlled trials with little effect beyond that seen in the control groups”.^[10]

The autonomic nervous system plays a central role in maintaining cardiovascular homeostasis by regulating the peripheral vasculature, and kidney function, which in turn affect cardiac output, vascular resistance, and fluid retention. Excess activity of the sympathetic nervous system increases blood pressure and contributes to hypertension.^[11,12,13,14,15]

There are a couple of possible mechanisms thought to be responsible for hypertension. The possible explanation is the impairment of baroreceptors response. The parasympathetic nervous system is not able to inhibit the increase of BP as it happens in normally functioning baroreflex.^[16] As a result, sympathetic tone prevails in modulation. Despite impairment of parasympathetic component, sympathetic tone is preserved. Arterial baroreceptors are reset to a higher pressure in hypertensive patients, and this peripheral resetting reverts to normal when arterial pressure is normalized.^[17,18,19] Furthermore, there is central resetting of the aortic baroreflex in hypertensive patients, resulting in suppression of sympathetic inhibition after activation of aortic baroreceptor nerves.^[20,21,22] The baroreceptors sensitivity resetting towards elevated BP is considered an important component of high BP maintenance.^[23]

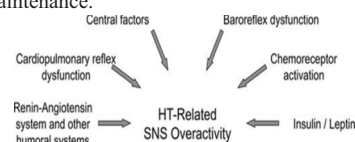


Figure 1.^[24] Schematic Drawing Of The Mechanisms Potentially Responsible For Sympathetic Activation In Hypertension (ht). Sns Indicates Sympathetic Nervous System.

The key mechanisms of hypertension is an imbalance of the regulatory systems of the body, so it makes sense to combine standard pharmacological treatment and biofeedback therapy.^[25] One of the non-pharmacological approaches used for the treatment of hypertension is relaxation therapy, which involves teaching the patient to accomplish a state of both muscular and mental deactivation.^[26]

Biofeedback is defined as a group of non-pharmacological therapeutic procedures that use electronic instruments to measure process and provide information to patients regarding their neuromuscular and autonomic nervous system activity in the form of analogue and visual as well as auditory signals.^[26]

The balances between the activities of sympathetic ("fight or flight response") and parasympathetic ("rest and digest response") divisions of autonomic nervous system leads to internal body homeostasis, including that of BP. Skin conductance, also known as galvanic skin response (GSR), electrodermal activity (EDA), is a simple, sensitive, and reproducible method of capturing function of the sweat (eccrine) gland as a marker sympathetic nervous activity.^[27]

In galvanic skin resistance biofeedback, the patient is connected to a transducer that indicates the galvanic skin resistance by means of a continuous auditory/visual signal. Sweat gland activity is thought to be a major factor mediating skin resistance; which is correlated with sympathetic nervous system activity. As relaxation progresses, skin resistance increases, resulting in a drop in the auditory/visual signal.^[1]

GSR is the electrical resistance recorded between two electrodes placed on the hand or on two fingers of the hand with a feeble electric current running between them. Alteration of GSR occurs as a result of change in autonomic tone, largely sympathetic. With sympathetic stimulation, there is slight increase in sweating which results in lower skin resistance due to presence of water and electrolytes in sweat. Thus a fall in GSR indicates a rise in sympathetic tone.^[28] increased GSR, which is an indicator of decreased sympathetic nervous system activity.^[29]

The present findings of an interaction between biofeedback and relaxation techniques would seem to be important, since it is known that relaxation itself has beneficial effects on lowering blood pressure in hypertensive patients. According to the relaxation theory of Benson, the integrated relaxation response i.e. decreased metabolism, slower rate of breathing, and decreased blood pressure and heart rate in association with feelings of calmness and control, works when the subject focuses on a mental device like a sound or fixed gaze at an object and returns to the focus when interrupting thoughts occur. Thus it is possible that biofeedback effects can be attributed to this general relaxation response and strengthened by relaxation training.^[10]

Some of the intervention studies have proved that structured relaxation therapies with GSRBF training results in parasympathetic dominance which causes significant reduction in blood pressure in patients with hypertension.^[29]

This is supported by a study by Elavally et al. in their study conducted home based relaxation training with GSRBF, where training showed increase in GSR, which indicates decreased sympathetic nervous system activity. Thus, helps in reduction of the blood pressure. Regular practice can result in significant reduction in systolic and diastolic blood pressure. Although, mean reduction in DBP is less than that of SBP in the study group.^[29]

A study conducted by Palekar et al where 40 Physiotherapy students having perceived stress score 20 or above were given GSRBF training for 3 weeks. The outcome measures of this study were pulse rate, respiratory rate, BP, and perceived stress. Perceived stress was assessed using PSS 10. The study shows significant reduction ($p < 0.001$) in physiological responses and perceived stress with GSRBF training.^[7]

The exact mechanism by which GSRBF, other biofeedback and behavioural techniques results in reduction in blood pressure is not known but it has been postulated that due to acute changes there is increase or decrease in cardiac output and heart rate while on long term there is reduction in total peripheral resistance. While other investigators postulates that there can be decreased sympathetic nervous system activity due to biofeedback-assisted relaxation which evokes an integrated hypothalamic response which reduces responsiveness to norepinephrine.^[1]

Thus, it can be concluded that GSRBF appears to be effective, safe, non-invasive, easy to perform and simple alternative measure to reduce blood pressure on long term basis. Study by Soheir MA. et al. in pregnant women showed significant reduction in both SBP and DBP as well as pulse rate thus reducing the incidence of hypertension during pregnancy. During pregnancy, mothers could get maximum benefit from extra rest from relaxation technique with biofeedback and this is especially important if there is a tendency towards hypertension.^[26]

Relaxation technique relaxes the skeletal muscles which elicits relaxation response. This in turn leads to release of tension in skeletal musculature. This calms down the mind, increases the peripheral blood flow, lowers the heart rate and blood pressure and slow and deeper breaths. This relaxation response counteracts the effect of sympathetic nervous system by promoting the action of parasympathetic nervous system. Also, the sympathetic nervous system is one of the controlling factors of renin angiotensin aldosterone system which is one of the regulators of the blood pressure.^[26]

In a study by Khanna et al. in hypertensive individuals, the GSRBF training group revealed significant reduction in SBP values ($p < 0.05$) while there was no effect on DBP on day 1. While on day 10 both pre and post sessions showed significant difference in both SBP and DBP values. The other 2 groups in the study included Progressive muscle relaxation (PMR) and control group. They concluded that both GSRBF and PMR group has shown significant reduction in pulse rate and anxiety score over a period of 10 days. Although results indicate the effectiveness of GSRBF training in reduction of BP after training session, PMR training was found to be more effective in reduction of BP while GSRBF was found to be more effective for respiratory rate.^[30]

In summary, compared to no intervention or other behavioural intervention in essential hypertension, GSRBF seems to be more effective in reducing SBP and DBP. The goal of the treatment is not only the reduction of blood pressure but also to prevent target organ damage such as stroke and heart failure. It also reduces the cost of overall direct and indirect costs for treatment of hypertension and its consequences constitute a substantial economic burden for our communities.^[31] Biofeedback research should also seek to investigate the activation status of the sympathetic nervous system and the psychological conditions affecting the prognosis of hypertension.^[10] Currently there are very few articles on GSRBF; further research on effect of GSRBF on blood pressure and hypertension can help in this.

Table 1:

Author/year of publication	Aim/purpose	Research design	Sample characteristics	Outcome measures	Key findings
1.Sujitha Elavally et al./2020	To investigate the effect of nurse-led home-based biofeedback intervention on the blood pressure levels among patients with Hypertension.	Randomized controlled study	Total samples of 346 with age group 35-75 years (173 study group, 173 control group)	SBP, DBP	Use of home-based biofeedback-centered Behavioral interventions enabled BP reduction among hypertensive patients.
2.Tushar J. Palekar et al./2015	To investigate the effectiveness of galvanic skin resistance-aided biofeedback (GSRBF) training in reducing the pulse rate, respiratory Rate, and blood pressure (BP) due to perceived stress in physiotherapy students	Quasi experimental study	Total sample of 43 with 8 males and 35 males of age >18 years.	SBP, DBP, PR, RR, PSS score	Galvanic skin resistance-aided biofeedback training is found to Produce a significant reduction in the pulse rate, respiratory rate, BP, and perceived stress in physiotherapy students.

3. Soheir M.A. El Kosery et al./2005	To determine the effect of biofeedback - assisted relaxation in reducing the incidence of hypertension during pregnancy	Quasi experimental study	25 pregnant women (12 primiparae and 13 multiparae) at 16 weeks' gestation in age ranged from 17 to 37 years.	SBP, DBP, PR, proteinuria	GSR biofeedback assisted relaxation was found to be effective as a prophylactic method in reducing the incidence of hypertension during pregnancy.
4. Archana Khanna et al./2007	Evaluating the effect gsr biofeedback training and progressive muscle relaxation on blood pressure and respiratory rate of the stressed individuals	Quasi experimental	20 stressed female students of age group 18–27 yrs	SBP, DBP, RR	PMR training to result in significant decrease in blood pressure whereas GSR biofeedback training showed a decrease in respiratory rate.

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