Review Article

BIOFEEDBACK IN MEDICAL PRACTICE

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ABSTRACT

Biofeedback is emerging as a non-pharmacological method of treatment, mainly as an adjunct in the management of a large number of common medical conditions seen in general hospital set-up. Origin of biofeedback, biofeedback methods and their clinical applications are discussed.

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KEY WORDS : Biofeedback, Electrodermal feedback; Electroencephalographic feedback; Electromyographic feedback.

Introduction

The concept of biofeedback has ancient antecedents in Medicine and Psychiatry. In Indian Medicine, Yogis used to practice the same in the form of yoga and transcendental meditation [1]. The term biofeedback, 'a real-time physiological mirror' was first coined in 1969 borrowing the feedback concept formalised by cybernetics during World War II. The development of biofeedback instruments represents an effort to apply modern electronic technology to the field of Psychiatry [2]. Biofeedback and applied psychophysiology, as tools, as objects of scientific inquiry, and as clinical interventions, have progressed from speculative experiments to data-based research, from trial clinical intervention to efficacy studies and accountability. These are multidisciplinary approaches, crossing the boundary between traditional professions such as medicine, psychology, physical therapy, occupational therapy, and other health care related fields [3].

Biofeedback may be defined as treatment method designed to facilitate self-regulation of bodily processes. In biofeedback, some aspect of individual's physiological functioning is systematically monitored using electronic instruments and fed back to that individual, typically in the form of an auditory and/or a visual signal so that he learns to modify that physiological function or process in some way. The discovery that some people can learn to control their internal responses such as heart rate and body temperature, is one of the important surprises of the twentieth century psychology and has major significance in therapy. With biofeedback it has been possible to train subjects to gain control over such functions as heart rate, blood pressure, skin temperature, muscle tension, and elec-

trical activity of the brain [4].

Origin of Biofeedback

The development of biofeedback could be traced to attempt to apply theories of learning for a better understanding of the operations in the autonomic nervous system (ANS) with its two subdivisions namely sympathetic and parasympathetic. For many years, it was thought that changes in physiological function could only occur as a result of involuntary or reflexive processes known as classical conditioning. Neil Miller challenged this assumption in a series of animal experiments demonstrating that operant conditioning of various ANS functions could be achieved [1]. Thus biofeedback initially emerged as a result of a theoretical controversy rather than as a practical solution of clinical problems. It is still a matter of debate whether the appropriate theoretical framework is operant conditioning, information processing or skill learning. After initial enthusiasm, it remained in the background with the introduction of pharmacological treatment [1]. The general realisation of the dependence potential of benzodiazepines and the risk of developing Persistent Withdrawal Syndrome in certain patients, has led to the increasing use of biofeedback techniques in medical practice. Thus, biofeedback is re-emerging at the fore front as an alternative form of therapy. Comparative outcome studies have shown that benzodiazepines are less effective in the treatment of minor mental disorders compared to non-pharmacological therapies [5].

Biofeedback Methods

Patients are carefully selected for biofeedback therapy after behavioural analysis. The physiological function to be brought under voluntary control is iden-

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Fig. 1 : Commonly used biofeedback equipments

tified and the appropriate biofeedback equipment is selected. There are several biofeedback instruments now available for use (Fig. 1) with varying degrees of sophistication, however, the basics remain the same. The sensor picks up the physiological function as an electrical activity, which is amplified and sent to a device that emits a signal which may be binary or analogue. The individual is explained the procedure and the working principle of biofeedback therapy. He is taught to recognise the different modes of feedback of his physiological function viz. the digital, the visual and the auditory. He is instructed to voluntarily bring the desired function under control as evidenced by shift of coloured light from red to green, change of unpleasant auditory signal to pleasant and increase or decrease in digital value. It takes a few sessions for the individual to achieve the desired goal and later he is advised to continue to practice till he is free of the symptoms for which the therapy is advocated. This procedure works better if the individuals are taught relaxation techniques prior to their induction into biofeedback therapy. Following are the important biofeedback methods used in medical practice:

(a) *Electromyographic (EMG) Biofeedback* : In this procedure, the electrical changes in the muscle groups are transduced into electrical signals that are subsequently displayed to the patient. The patient then sees or hears the transformed EMG signals that are proportional to the degree of muscular activity. Most EMG biofeedback treatments measure the activity of the Occipitofrontalis muscle or adjacent areas by placing three fairly large surface electrodes symmetrically across the frontalis muscle approximately one inch above the eyebrow (Fig. 2). This arrangement measures the muscular activity from the two outer electrodes using the central electrode as a reference point [1,6].

Fig. 2 : Patient receiving biofeedback treatment

(b) *Thermal Biofeedback* : Biofeedback of skin temperature is another widely used method for treating patients to control blood flow. Blood flow in the hands is a function of peripheral vasodilatation/constriction regulated by smooth muscles innervated by the sympathetic nervous system. Because the peripheral vasculature is primarily alpha-adrenergically innervated, control of digital temperature provides an example of voluntary control of the sympathetic nervous system. Finger temperature is used as an index of stress. Vasoconstriction in the digits is associated with sympathetic arousal, which results in reduction of skin temperature. Consequently, patients receive feedback changes in the skin temperature, which serves to promote the ability to voluntarily warm the hands. This procedure has been employed in a variety of conditions, particularly, peripheral vascular disorders (e.g. Raynaud's Disease), vascular headaches and hypertension [1,7,8].

(c) *Electrodermal (EDR) Biofeedback* : Electrodermal biofeedback is a measure of skin conductance and includes Galvanic Skin Response (GSR), Skin Potential Response (SPR) and Skin Conductance Level (SCL). Theoretically, increased sympathetic activation is reflected by increased sweat gland activity. Unlike EMG or temperature feedback, EDR feedback has few specific application and is usually employed when the goal is simply a general reduction in sympathetic tone [1,2].

(d) *Electroencephalographic (EEG) Biofeedback* : Electroencephalographic biofeedback is a measure of electrical activity in the brain and is employed to modify certain brain wave frequencies. For example, alpha, a wave in the 8-12 Hz range, has been associated with states of relaxation and calm and is often recorded from the Occipital region. In addition to its use

in general relaxation procedures, EEG feedback has been used to treat conditions ranging from dyslexia to epilepsy [1,4].

Clinical Applications

There are many common clinical conditions where biofeedback has been used as a non-pharmacological modality of treatment. A few of them are discussed below:

(a) *Headaches* : Biofeedback is the most common non-pharmacological treatment of headache. Frontalis EMG biofeedback is currently recognised as the treatment of choice for muscle contraction headache by the Biofeedback Society of America (BSA). For migraine or vascular headaches, three main approaches have been advocated:

(i) Thermal biofeedback.

(ii) Thermal biofeedback + Autogenic training.

(iii) Biofeedback training to control vasomotor activity of external temporal artery.

Autogenic training is a behavioural technique in which the therapist teaches the client to engage in autosuggestion to induce deep muscle relaxation. Current evidence suggests that thermal biofeedback and autogenic training may be the most effective treatment for migraine. An average rate of clinical improvement occurring from biofeedback is between 40 and 70 per cent. Patients who have severe complaints tend to respond less well [1,2,9-11].

(b) Cardiovascular disorders

(i) Hypertension: Biofeedback in humans is technically more difficult because continuous and immediate blood pressure recordings are not easy to obtain. Standard sphygmomanometry is too cumbersome, automatic cuffs are too slow and invasive procedures such as direct arterial catheterisation are also not used routinely because of obvious stress and trauma. A non-invasive procedure that has been widely employed is a constant-cuff technique. Which was employed by Shapiro and co-workers. What is followed in most of the biofeedback units these days is EMG biofeedback relaxation which lowers blood pressure by more than 20 mm Hg systolic and 10-15 mm Hg diastolic. These effects are evident in both medicated and unmedicated patients. An alternative procedure is to provide feedback of pulse wave velocity and it is likely to be more widely used in future. Biofeedback may be useful in treating hypertension but it should not be concluded that it is a replacement to pharmacological treatment [1,2].

(ii) Cardiac arrhythmias: Several teams of investigators have reported successful results in training patients with sinus tachycardia, paroxysmal atrial tachycardia, atrial fibrillation and premature ventricular contractions. These studies are considered preliminary and further research would be worthwhile before claiming that biofeedback is an established treatment for any of these disorders [1].

(iii) Raynaud's disease : Patients suffering from Raynaud's disease can be trained to control peripheral skin temperature. Several case studies have shown that these patients report fewer vasospastic attacks after treatment with temperature biofeedback alone or in combination with autogenic training [1].

(c) *Neuromuscular Rehabilitation*: Some of the earliest applications of biofeedback have been for the treatment of neuromuscular diseases.

(i) Spasmodic Torticollis: EMG biofeedback alone or in combination with relaxation therapy has been used by many workers and claimed to be successful in treating spasmodic torticollis and retrocollis patients. In this, patients are trained to relax the spasm and later to increase the EMG activity in the atrophied muscle group on the side contralateral to the spasm [1].

(ii) Blepharospasm: Cases of blepharospasm proven to be highly refractory to traditional Ophthalmological and neurological intervention have been found to be responsive to EMG biofeedback in the form of reduced spasm [1].

(iii) Chronic Pain : EMG biofeedback has been used to treat patients with low backache and myofascial pain of temporomandibular joint. In addition, numerous other neuromuscular disorders, including spinal cord injuries, Huntington's Chorea, Parkinson's Disease, tremors, hemiparesis due to head trauma or cerebral palsy, muscular atrophy secondary to surgery and injury to the flexor tendons of the hands have been treated by using biofeedback [1].

(d) *Gastrointestinal Disorders*: The most widely accepted application of biofeedback in gastrointestinal disorders is in the treatment of fecal incontinence. The first biofeedback treatment for fecal incontinence employed visual feedback in which patients were taught to contract the external sphincter in response to rectal distension. Three balloons are used for this; two of them for measuring the response of internal and external sphincters and the third in the rectum to simulate the sense of fecal material when inflated. Patient is given feedback (eg. praise or actual observation of the polygraph) for successfully performing the desired response. Treatment progresses until the patient is able

to contract the external sphincter to minimal stimulation. Engel and co-workers initially reported success with four out of six patients; subsequently study of fifty patients by Cerulli, Schster and co-workers reported reduction in the frequency of fecal incontinence in 72% of the patients. These findings have been replicated in patients with incontinence as a result of a variety of conditions including incontinence secondary to meningomyelocelè, multiple sclerosis and imperforate anus. Biofeedback training has become the treatment of choice for fecal incontinence resulting from sphincter incompetence or impaired ability to perceive rectal distension [1].

Biofeedback techniques have also been used successfully to treat a variety of gastrointestinal disorders especially peptic ulcer disease, inflammatory bowel disease and irritable bowel syndrome. More studies are required to confirm its effectiveness in these conditions since most of the reports pertain to small patient samples [1].

(e) *Other disorders:* Electroencephalographic feedback has been used in the treatment of epilepsy and to produce "alpha states". Conditions like bronchial asthma and insomnia have been subjected to biofeedback manipulation. As all the neurotic disorders have chronic anxiety and tension which gets transformed into somatic symptoms like headache, bodyache etc., biofeedback, works wonders in these [1].

Conclusion

Biofeedback as a non-pharmacological treatment modality, has clinical applications for a wide range of medical disorders today, though, it is not a panacea for all medical problems. It has proved to be a useful adjunct to traditional medical treatments for such disorders as headaches, hypertension, chronic pain and Raynaud's Disease. In some conditions such as muscle contraction headaches and fecal incontinence, biofeedback with relaxation therapy is actually the treatment of choice. Biofeedback is effective in disorders which are chronic in nature and where specific therapy is not available, or other modalities of treatment are ineffective. In the management of neurotic disorders, biofeedback has worked wonders. Selection of cases is of paramount importance for biofeedback to be effective.

It is known to reduce the dose of the drug, severity of symptoms, frequency of episodes and in general, improves the quality of life.

REFERENCES

1. Blumenthal JA. Relaxation therapies and biofeedback: Applications in Medical Practice. In: Jesse OC Jr, ed. Consultation-Liaison Psychiatry And Behavioural Medicine. Philadelphia: WB Saunders, 1988; 272-83.
2. Charles F, Strobel. Biofeedback And Behavioural Medicine. In: Kaplan HI, Sadock BJ, eds. Comprehensive Text book of Psychiatry. 4th ed, Baltimore: Williams and Wilkins, 1985; 1466-72.
3. Amar PB. Biofeedback and applied psychophysiology at the cross-roads. Biofeedback Self Regul 1993;18(4):201-9.
4. Rimm DC, Masters JC. Behaviour Therapy Techniques And Empirical Findings. 2nd ed. New York: Academic press, 1979;448-54.
5. Higgit A, Fonagy P. Withdrawal from benzodiazepines and the persistent benzodiazepine dependence syndrome. In: Kenneth granville-Grossman, eds. Recent Advances in Clinical psychiatry, Vol 8. Edinburgh: Churchill Livingstone, 1992;45-57.
6. Flor H, Birbamer N. Comparison of the efficacy of electromyographic biofeedback, cognitive therapy, and conservative medical interventions in the treatment of chronic musculoskeletal pain. J Consult Clin Psychol 1993;61:653-58.
7. Otis JD, Rasey HW, Vrochopoulos S, Wincze JP, Andrasik F. Temperature acquisition as a function of the computer-based biofeedback system utilised: an exploratory analysis. Biofeedback Self Regul 1995;20(2): 185-90.
8. Grimsley DL. Digital skin temperature and biofeedback. Perceptio Motor Skills 1994;79:1609-10.
9. Grazzi L, Bussone G. Effect of biofeedback treatment on sympathetic function in common migraine and tension-type headache. Cephalgia 1993;13(3) 197-200.
10. Arena JG, Bruno GM, Hannah SL, Meador KJ. A comparison of frontal electromyographic biofeedback training, trapezius electromyographic biofeedback training and progressive muscle relaxation in treatment of tension headache. Headache 1995; 35(7): 411-21.
11. Blanchard EB, Appelbaum KA, Guarnieri P, Morril B, Dettiger MP. Five year prospective follow-up on the treatment of chronic headache with biofeedback and/or relaxation. Headache 1987;27:580-83.
12. Rice KM, Blanchard EB, Purcell M. Biofeedback treatments of generalised anxiety disorder: preliminary results. Biofeedback Self Regul 1993; 18(2): 93-105.