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THE EFFECT OF FUNCTIONAL ELECTRICAL STIMULATION ON SELF-CONCEPT, LOCUS OF CONTROL, ANXIETY AND DEPRESSION IN SPINAL CORD INJURED PATIENTS

by

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ABSTRACT

The purpose of this study was to empirically investigate the anecdotal claims regarding the psychological benefits of Functional Electrical Stimulation (FES) for spinal cord injury (SCI) patients. FES referred to computer-controlled electrical stimulation to muscle groups in the paralyzed legs of paraplegics and quadriplegics in order to move muscles in such a way as to exercise them. Studies have suggested that aerobic activities promote positive psychological effects. Hypotheses proposed that FES exercise would increase self-concept, focus control of reinforcement inward, decrease anxiety, and decrease depression.

This investigation contrasted responses of 19 SCI white male outpatients participating in a regular FES exercise program (Treatment Group), with the responses of 14 of their counterparts on the waiting list for the treatment (Waiting List Group). Patients were administered standardized paper and pencil tests in an individual structured interview. The instruments were the Tennessee Self-Concept Scale, The Internal-External Scale, State-Trait Anxiety Inventory, and Beck Depression

Inventory. In addition, the Peabody Picture Vocabulary Test-Revised and a demographic questionnaire were administered.

In order to analyze the difference between the groups as measured by the scales, the Student's t test was employed. The Treatment Group did not evidence a significant difference from the Waiting List Group on the psychological dimensions of self-concept, locus of control, anxiety, and depression. Within self-concept, however, two subscales did differ significantly in favor of the treatment group. In addition, auxiliary analyses showed quadriplegics with higher self-concept and state anxiety than paraplegics. Within self-concept, again, several subscales differed significantly in favor of the Treatment Group when analyzed within the diagnoses of paraplegia and quadriplegia.

A pattern began to emerge that suggested the FES exercise did enhance some aspects of self-concept, especially for the quadriplegics. Nonsignificant findings were discussed in light of the equivalence between the Treatment and Waiting List Groups, interviewer/subject bias, and instrumentation. The four psychological components, as well auxiliary findings, were further evaluated. Incorporated were implications for further research and rehabilitation recommendations.

Chapter 1

Introduction

'As you ought not to attempt to cure eyes without head, or head without body, so you ought not to treat body without mind.' (Socrates, ca. 400 BC)

Nowhere in medicine can it be imagined that the Socratic admonition above carries greater validity than in the comprehensive treatment and rehabilitation of spinal cord injured individuals. Reflection on the many problems to which the cord injured person must make an adjustment impresses one with the gravity of the psychological processes which occur following cord injury. Such an individual is confronted with grieving over his loss, coping with pain and phantom sensations, alterations in sexual functioning, loss of bladder and bowel control, the frustrations of immobilization, loss of vocational goals and earning capacity, feelings of uselessness, role reversals in the family and attendant loss in self-esteem, and the social stigma of being 'different' in the public's eye. It is an amazing tribute to the flexibility and magnificence of the human spirit

> that so many people whose lives are thus devastated survive and function at the level of physical and social independence which most cord injured people achieve. (Hohmann, 1975, p. 81)[1]

With a decrease in mortality and an increase in rehabilitation for the spinal cord injured, an important goal is to maximize independence. "The importance of psychological factors in the effectiveness of rehabilitation and adaptation after injury has been increasingly recognized" (Frank, Umlauf, Wonderlich, Ashkanazi, Buckelew, & Elliott, 1987, p. 727).

Functional electrical stimulation (FES), or "the use of electricity to evoke a skeletal muscle response" (Functional Electrical Stimulation [FES]: Rehab Brief, 1986, p. 1), has been employed to increase independence by improving physical function. Functional electrical stimulation is an electrical impulse to a muscle, or group of muscles, applied to produce a physical response or improve function. For the purposes of this study, FES specifically refers to computer-controlled electrical stimulation to muscle groups in the paralyzed legs of paraplegics and quadriplegics in order to move muscles in such a way as to exercise them.

Physical and medical effects of FES have been researched and documented (Arnold, 1987; Clausen,

Klausen, Rasmussen, & Trap-Jensen, 1973; Davis et al., 1988; Glaser, 1986; Glaser et al., 1987; Green et al., 1986; Jacobs, 1989; Kralj, Bajd, & Turk, 1980; Phillips, 1988a; Petrofsky & Phillips, 1984; Phillips, Petrofsky, Hendershot, & Stafford, 1984; Ragnarsson, 1988; Servedia, Servedia, Davis, Stull, & Glaser, 1987; Zwiren & Bar-Or, 1975). However, a search of the literature revealed no empirical studies focusing on the psychological effects of FES on spinal cord injury (SCI). The closest research was a case study of the psychological effects of aerobic exercise training with a paraplegic patient (Katz, Adler, Mazzarella, & Ince, 1985). Though Nestoros, Demers-Desrosiers, and Dalicandro (1982) did not focus on FES, they did look at the SCI population. Their observation was reflected findings in this study: "Our review of the literature, supplemented by computerized search, failed to reveal any studies on the self-assessment of emotion in spinal cord injured patients" (p. 827). This investigation, then, will examine the psychological effects of FES on SCI.

Patients enrolled in an FES program have often praised its physical and psychological benefits, with comments like, "I feel great after a 'run!'" and "It's like a 'runner's high!'" They report increased energy, activity, and involvement. Two patients in this study

remarked that FES "keeps me in the best possible shape," and "I feel plain 'good' -- no, 'excellent'. I can't wait for the next time. At the end of a run, I have a big grin on my face, like others would need blinders when they see my smile!"

Clinical studies have employed computerized closed-loop functional electrical stimulation technology, and report that "conditioning derived from this therapy not only trains but also improves the entire cardiovascular system" (Jacobs, 1989, p. 26). Additional physical benefits include "a reduction of pressure sores and genito-urinary infections, improved bowel and bladder control, and ... an increased capacity for physical activities" (p. 26).

Psychological benefits have been discussed in the literature via anecdotes. Psychological benefits have been enthusiastically reported by patients, therapists and physicians among themselves. This study will attempt to empirically support the anecdotal claims that FES increases self-concept, focuses control and reinforcement inward, and decreases anxiety and depression.

An article by Woodbury (1978) states:

> Survival following traumatic injury to the spinal cord is a twentieth century phenomenon. Advances in medical technology have enhanced the

> likelihood of average longevity among individuals with a spinal cord injury (SCI). Advances in psychology and other helping professions are now needed to enhance the likelihood that these lives will be satisfying and productive. Rehabilitation has become a realistic goal, and the emphasis now includes quality of life as well as longevity. Now that SCI is not such an immediate threat to life, fostering psychological adjustment following SCI has been increasingly recognized as a major factor in rehabilitative efforts. (p. 119)

Spinal Cord Injury

Spinal cord injury is defined as a lesion of the spinal cord that results in paralysis of specific parts of the body, with corresponding loss of sensation. Paraplegia involves paralysis from approximately the waist down. Quadriplegia involves paralysis from approximately the shoulders down (National Spinal Cord Injury Association [NSCIA], 1988a).

Motor vehicle accidents cause about 50% of all spinal cord injuries, with most of the others accounted for by falls, diving and other sporting mishaps, and results of violence such as gunshot and stab wounds.

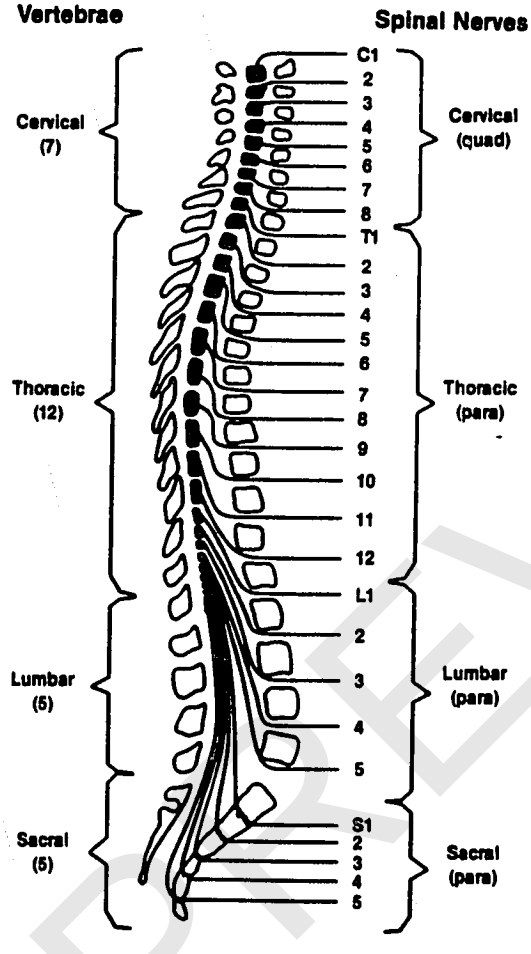
About 80% of the injuries are incurred by males when they are between the ages of 16 and 25 years old (NSCIA, 1988a; Stover & Fine, 1986).

Anatomy of the spinal cord.

The average spinal cord is a chalk-sized cable, made up of millions of nerve fibers and cells, surrounded by a bony tube and made up by a series of rings. These rings, or individual vertebrae, are numbered in three series: cervical, thoracic, and lumbar vertebrae (see Figure 1). They begin at the top of the neck and go down. There are seven cervical, twelve thoracic, and five lumbar vertebrae. At the bottom is the sacrum and coccyx, or tailbone (Travis, 1976).

Emerging from each side of the bony rings or vertebrae are nerves that are numbered according to the vertebrae from which they protrude (See Figure 1). For example, "C4" refers to the site of spinal nerves that supply impulses to the lower part of the neck; "C5" refers to the shoulders; "T12" refers to the trunk muscles, and so on (Travis, 1976).

Figure 1. Relationship of Vertebrae, Spinal Cord and Spinal Nerves.



Haymaker, W. and Woodhall, B. (1945) Peripheral Nerve Injuries: Principles of Diagnosis. W. B. Saunders Company, Philadelphia

C-2 through C-4: These patients have no movement of the upper extremities, although there is some control of the neck muscles. The C-2 patient requires ventilatory support, while the C-4 patient usually does not.

C-5: The C-5 patients have use of their biceps, can feed themselves with the aid of special equipment and perform simple activities of daily living such as grooming.

C-6: These patients have use of their wrists. They can be independent in grooming and bathing, driving and preparing a simple meal.

C-7: In addition to the above activities, C-7 patients can straighten their arms. Some patients are capable of total independence and can live alone with some adaptations in their homes.

T-1 through T-6: The T-1 patient has all cervical segments intact and has normal hands. The patient should be capable of independent living in a wheelchair accessible environment. A patient with a T-6 injury has much better breathing due to control of chest muscles.

T-12: The T-12 patient has complete trunk control, with good abdominal muscles. Sitting balance is good. Ambulation may be possible with long leg braces, though very difficult.

L-4: The L-4 patient has use of the hip flexors and quadriceps. He can extend his knees and raise his feet. There is still some paralysis in the back of the legs, but ambulation is possible with the assistance of short leg braces.

Spinal reflex activity regulating autonomic processes such as bladder and bowel function is usually present in patients with lesions at T-12 or above, but is usually absent at L-1 or below.

Note. From Spinal Cord Injury: Facts and Figures (p. 26) by S. L. Stover and P. R. Fine (Eds.), 1986, Birmingham: University of Alabama at Birmingham. Copyright 1986 by The University of Alabama at Birmingham. Adapted by permission.

> Overall, cervical lesions account for slightly more than half the injuries (53.2%) compared to thoracic lesions which account for slightly more than one-third (35.6%). Lesions in the lumbar and sacral segments are relatively rare; combined, they account for only 10.1 percent of all reported SCIs. (Stover & Fine, 1986, p. 29)

Feeling and movement relate directly to the functioning of the spinal cord. Hence, the higher the injury, the more extensive the paralysis. For example, a person with a "broken neck" involving the C4 vertebra is not able to breathe without outside assistance. The C4 spinal nerve which enervates the muscles involved in breathing is interrupted. The patient is completely dependent on external support equipment to breathe. However, if an injury involves C5, depending on the extent of the injury, the patient can bend his elbows and retain some movement in the shoulders; if the injury occurs at C6, he can also extend his wrist (Travis, 1976). If an injury is in the middle back, the patient is likely to have normal function in his arms and chest (Travis, 1976).

Reflex activity occurs <u>in</u> the spinal cord. Reflexes differ from other movements in that the sensory input does not go to the brain for processing and then travel