

STANDING AND ITS IMPORTANCE IN SPINAL CORD INJURY MANAGEMENT

ABSTRACT

A broad spectrum of physiological problems is associated with lack of gravitational stress in the individual with spinal cord injury. Prolonged immobilization results in systemic de-adaptations, which include cardiovascular changes, the alteration of calcium homeostasis, which leads to bone de-mineralization and risk of injury calculi.

Weight bearing in the standing posture has been shown to ameliorate many of these problems and offers physiological advantages for the individual with spinal cord injury.

There are also significant psychological and social benefits to standing, including improved self-image and eye-to-eye interpersonal contact. Increased vocational, recreational and daily living independence are additional benefits to standing.

INTRODUCTION

As of 1980, there were over five million Americans with spinal cord injuries and five thousand to ten thousand new injuries occurring each year (36). While the impact of spinal cord injury on the individual in terms of health, employment and personal economics is inestimable, the economic cost to society in direct costs of medical and rehabilitation services, and indirect costs for loss of earnings and services was estimated in 1977 to be nearly three billion dollars (35). Improvement in long-term management of spinal cord injury has immense importance for the individual and for society as a whole.

This paper is a review of the current literature relating to standing, weight-bearing and related postural therapies such as tilting, in person with spinal cord injuries.

The relationship between immobilization and bone remodeling, has been long established (1,2,3,4,6,8,10,12,17,18,19,32), as has the relationship between hypercalciuria and urinary tract calculi (1,13). Reversal or amelioration of these deleterious effects with weight bearing has been documented in spinal cord injuries (13,18,19,20) and non-injured (10,22,27,31) individuals, although, the mechanism of improvement is not fully understood.

The role of standing and weight bearing is also explored in other

complications of spinal cord injury with emphasis on effects of standing on the cardiovascular system, pressure sore development, spasticity and contracture, psychological and psychosocial functioning, vocational, daily living and recreational activities.

DISCUSSION

Mechanics of Weight Bearing and Bone Remodeling

Heaney showed the disuse osteoporosis results from active degradation of bone through calcium loss rather than failure of bone formation as was previously thought (17). Hypercalciuria concomitant with bone loss occurs in both healthy and traumatized individuals during prolonged bed-rest immobilization and weightlessness (1,2,3,4,6,8,10,12,17,18,19,32).

The relationship between calcium metabolism and the mechanics of weight bearing are complex. Weight bearing has been long thought by many to be one of the most important factors in remodeling of the long, weight-bearing bones (8,9,13,18,19,27). Other factors include calcium, protein and other nutrient intake (1), muscular contraction (1,7) and cyclic mechanical loading (24,34).

Studies by Kaplan, Issekutz, and Freeman have shown passive standing and weight-bearing therapy to substantially decrease bone loss as measured by the difference between calcium intake and excretion (13,18,19,20). Reversal of the bone loss experienced by astronauts after prolonged weightlessness occurred after considerable time under normal activity under full gravity (10,27).

Claus-Walker shows that hypercalciuria correlates closely to time after injury, with calcium loss at a high rate during the period immediately following spinal cord injury and generally reaching stasis (5). Claus-Walker reported that weight bearing did not lower hypercalciuria immediately (6). Although an upright posture instituted with recently injured tetrapelgic patients "improve their clinical status and shortens the duration of the ever-present hypercalciuria". (7)

Renal and Urinary Function and Standing

Urinary tract infection occurred in 66% to 70% of persons with spinal cord injury during the initial medical/rehabilitation period and an average of 37% over a five-year follow-up period according to Young (34). Clearly, this represents both a serious danger, and a significant cost factor in management of spinal cord injury.

Gould showed bladder pressure to be 2.5 to 3 times higher in the standing posture than in the supine position (16). Urine is drained more completely during micturition in the standing position, and residual urine reduced. Reduced residual urine reduces the incidence of bladder infection (37,38).

Urinary tract calculi occur in spinal cord injured persons with high frequency (8,34). Calculi in both bladder and kidneys have been shown to correlate strongly with hypercalciuria and immobilization (2,5,8). Freeman reported the incidence of calculi was reduced in patients after attempted ambulation and weight bearing (13). Improved cardiovascular response to orthostatic stress also benefits the kidney function, as evidenced by increased or maintained glomerular filtration rate (30).

Weight bearing, Muscular Stretching and the prevention of Contracture and Spasticity

The limitation of range of motion caused by contractures has serious impact on mobility and independence for the individual with spinal cord injury. Other methods of preventing contractures, including manual therapy, are difficult and expensive to initiate and maintain as they require extended professional time. Leo cites a study by Odeen of patients discharged without access to physical therapy who maintained range of motion solely through passive standing (26).

Odeen and Knutsson measured the muscle tone of 9 people with spastic paraparesis and after a regimen of stretching and loading (weight-bearing) and found that after weight bearing in the standing position spasticity in dorsi flexion was reduced an average of 32%, and in planter flexion the reduction was 26%. By comparison, they found reduction after stretching in supine position to be only 17%.

Abramson's assertion that muscular contraction is the signal factor in preventing disuse osteoporosis (1) reinforces the need to continue support of research combining standing and weight-bearing with FES and other forms of exercise to develop a system of maximal conditioning.

Circulatory Benefits of Standing

People with spinal cord injury have insufficient orthostatic regulation by the nervous system. Stress on the heart due to standing induces a beneficial adaptation. Adaptation to repeated stress improves the cardiovascular response (26). Krebs postulates the "adaption of spinal man to the upright position may involve the recovery of a spinal vasomotor reflex involving the splanchnic circulation" (21). Figoni sites abdominal and thoracic pump,

muscular contraction and improved tonus of resting muscles as factors in tilting which aid circulation (12).

Ragnasson has found the head up tilt position for quadriplegics to be “an effective method to reduce orthostatic hypotension by improving circulatory adjustment” as evidence by the ability of quadriplegic patients to maintain glomerular filtration rate during head tilt (28). By implication, this population may achieve improved renal as well as cardiovascular function by standing.

Skin Breakdown and Pressure Relief

Pressure sores are second only to urinary tract infections in incidence of medical complications of spinal cord injury (11,34) with costs for hospitalization due to severe pelvic sores averaging between \$1760 and \$4000 in 1980 (34).

To be effective in preventing skin breakdown and the formation of decubitous ulcers, pressure relief must be frequent, sufficient and preferably self-initiated (37,38). Regular standings allow a more sustained period of relief to sacral and ischial high-pressure areas of the buttocks than can be achieved by push-ups. A device for standing at will throughout the day would provide greater pressure relief options to the user than a standing frame which is fixed in position. Air circulation during standing lowers temperature and humidity at the seating interface – both significant causal factors in pressure sore development (29).

Psychological and Psychosocial Benefits of Standing.

Depression associated with negative self image has disastrous effects on the individual (with or without disability), psychologically as well as physically. The standing posture projects a proactive image of the whole person in the general social environment. It allows face to face conversations, and eye to eye contact, which can be effective in modifying both self image of the individual and the response of others in the community.

Vocational Benefits of Standing

Standing greatly reduces the modifications to the workplace required for access to many jobs. Individuals are now in the workforce using stand-up mobility devices in diverse professions including the practice of surgery, machine operation, and employment as bank teller, beautician and teacher. The implied authority of the standing posture, with its negation of visual stereotypes has proven valuable to people in leadership roles such

as business seminar leaders and university professors. Technology to facilitate standing within an active academic or work environment represents an economical alternative for institutions and individuals that cannot afford to make permanent and most often expensive architectural modifications.

Standing and Activities for Daily Living

Independence in daily living and recreational activities is greatly enhanced by the increased range of reach available. Access to upper shelves and cabinets, appliance controls, ticket windows, automated teller bank machines are environments that are more effectively approached while standing. In some cases, such as cooking at a hot stove, or operating dangerous power tools, the improved angle of view and unimpeded reach may be considerably safer. Technology to facilitate standing represents a cost effective method of adapting the person to the environment rather than customizing the home at greater expense.

Recreational Opportunities Afforded by Standing

The opportunity to recreate together with family and friends promotes relationships, self-worth and personal growth. Archery, bowling, and golf are a few of the sports for which standing may be the posture choice. Often, however, standing is not an option due to lack of a device or system.

Devices and Systems for Standing

For the benefits of weight bearing, standing and postural therapies to be felt, technology must be available to facilitate them. Existing devices include, stationary standing frames, manual and powered standing mobility devices, tilting boards and braces. While braces and brace walking are often not seen as a functional mobility

alternative they are an important therapeutic option and may come to the fore in combination with FES in the future. Mobile standing devices in general offer more benefit psychosocially than do fixed location standing frames and provide opportunities for standing throughout the day. More work in developing and deseminating such technologies is needed.

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CONCLUSIONS

Spinal cord injuries have enormous physical, emotional and economic

consequences for the individual and the society. Optimization of function and prevention of medical complications is of the utmost importance.

Standing has demonstrable value in many aspects of the management of spinal cord injury. The interlocking nature of physiological systems impacted by spinal cord injury sometimes make casual relationships difficult to establish and further study is required to reconcile some conflicting results such as those of Claus-Walker (6), and Kaplan (19).

Development of devices and systems to facilitate standing is important. The combination of standing with other forms of exercised and conditioning and with mobile capabilities are areas of great promise for further research.

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