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Case Report
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Effect of Cooling Intervention on Reducing Rigidity in Parkinson's Disease: A Case Report

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Abstract

Objective: Describe potential changes in parkinsonian rigidity after an administration of cooling intervention.

Methods: Two patients with Parkinson's Disease (PD) participated in the study that applied the forearm cooling intervention and objectively evaluated rigidity at the wrist joint through a cycle of passive flexion and extension movements of ±45° at a velocity of 50°/sec. Both patients underwent a baseline assessment (Pretest), and an immediate assessment after cooling intervention (Posttest) and 30 minutes after the cooling (30-min Posttest). Rigidity temporal score (Nm-sec) and work score (Nm-deg) were used to quantify and compare rigidity between the Pretest and the Posttests.

Results: In Case #1, there were reductions in both rigidity scores at Posttest and relatively smaller reductions at 30-min Posttest after cooling. Case 2 demonstrated a slight increase immediately posttest which was followed with a slight decrease at 30-min Posttest.

Discussion and Conclusion: Cooling intervention appears to be a promising therapy in treating parkinsonian rigidity. Future research on a larger sample size is warranted for further investigation of the effectiveness of cooling therapy.

Keywords: Parkinson's disease; Rigidity; Physical therapy; Cooling intervention

Introduction

Parkinson's Disease (PD) is a chronic, progressive neurodegenerative disease that is characterized by both motor and nonmotor symptoms including but not limited to bradykinesia, rigidity, cognitive impairments, and fatigue [1,2]. As the disease advances, PD symptoms become more severe. Rigidity progresses more relentlessly than other cardinal symptoms [3-5]. Rigidity is defined as an increased resistance to passive movement of a limb persisting throughout its range of motion, also referred to as hypertonia [6]. Many studies have shown that patients with PD exhibit a marked increase in long-latency stretch reflexes, compared to healthy controls [7-10]. Exaggerated stretch reflexes are the primary mechanism underlying parkinsonian rigidity.

Research has suggested the beneficial effects of rehabilitation programs, such as physical therapy, on the treatment of PD [11,12]. But the effect of physical therapy on reducing rigidity in PD remains unknown. Nevertheless, there is a body of evidence on the effectiveness of physical therapy treatment in managing spasticity. Rigidity and spasticity share common clinical signs, and both are characterized by hypertonia [9,10]. Cooling therapy (or cryotherapy) has been widely used to manage spasticity in clinical practice with its efficacy judged mainly by clinical assessments. Furthermore, numerous studies have demonstrated positive effect of cooling on reducing spasticity in upper motor neuron syndromes [13-17].

None of the study has examined the effect of cooling intervention on rigidity. Based upon evidence that cooling is effective in decreasing spasticity, we hypothesized that rigidity could potentially be decreased by cooling therapy. The purpose of this case report was to describe the effects of the cooling intervention on rigidity at the wrist joint in two subjects with PD.

Case Presentation

Participants

Two patients with idiopathic PD participated in this study. One was a 76-year-old man with disease duration of 2 years, and the other was a 70-year-old woman with disease duration of 7 years. The Hoehn and Yahr stages were 2.5 and 2, respectively. In both cases, the left side exhibited greater

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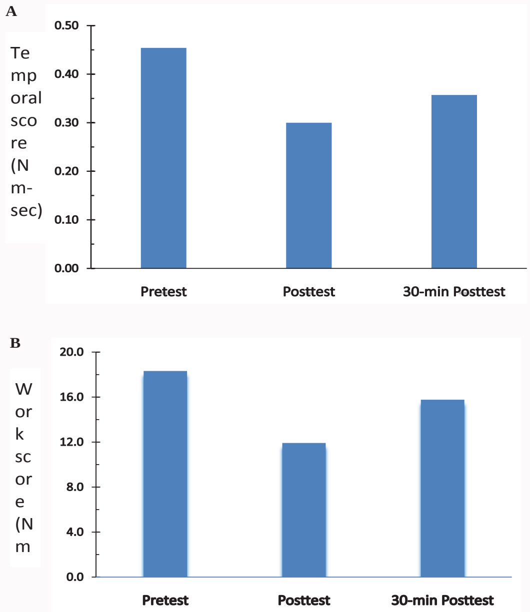

Figure 1: Rigidity scores measured at three time points for Case #1: before cooling therapy (Pretest), immediately after cooling therapy (Posttest), and 30-min after cooling (30-min Posttest). **A**: Temporal score; **B**: Work score.

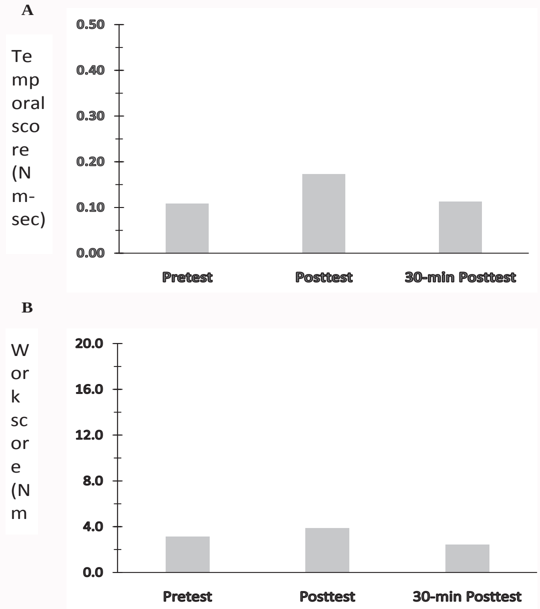

Figure 2: Rigidity scores measured at three time points for Case #2: before cooling therapy (Pretest), immediately after cooling therapy (Posttest), and 30-min after cooling (30-min Posttest). **A**: Temporal score; **B**: Work score.

rigidity. Both were instructed not to alter their medication routine during the participation. The experimental protocol was approved by the Institutional Review Board of the University of St. Mary in Leavenworth, Kansa, USA. Informed consent was obtained from each patient prior to the participation.

Protocol

The procedures included the Motor Examination of the Unified Parkinson's Disease Rating Scale (UPDRS) [18] and then an objective assessment of rigidity [19-23]. For objective assessments, each patient was seated in a height-adjustable chair with the left hand being held in a manipulandum. The elbow was in approximately 120˚ of flexion with the wrist and forearm in neutral. Each patient was instructed to remain relaxed during passive wrist flexion and extension movements generated by the servomotor. Each trial began with the wrist at approximately 45˚ of wrist extension and moved through a central range of motion of 90˚ (±45˚) at a constant velocity of 50˚/sec. Details on the objective assessment of rigidity have been described previously [19-23].

After the baseline assessment (Pretest), a cooling intervention was administered, and then followed by an immediate assessment of rigidity (Posttest) and subsequently a 30-minute post-cooling assessment (30-min Posttest).

Cooling intervention

A cooling garment was utilized and applied to implement the cooling intervention. The initial temperatures in the skin near elbows of the tested limbs were 30.4˚C and 31.7˚C for the two patients, respectively. The left forearm of each participant was wrapped in the garment with embedded fluid channels supplied with circulating fluid by a commercial chiller (Polar Products, Inc., OH), until the skin temperature near the elbow that was concurrently monitored by a traceable digital thermometer with a probe (Fisher Scientific, Co., NH) cooled to 25˚C. The cooling continued for additional 15 minutes. At the end of this duration, the cooling garment was then removed from subjects' forearms. Immediately, the objective assessment of rigidity was performed (Posttest), and performed again 30 minutes after the removal of the garment (30-min Posttest).

Outcome measures and data analyses

Joint torque and angular position about the wrist were recorded from each participant. Torque was quantified by integrating the rectified torque with respect to time (i.e., "temporal or angular score" in Nm-sec) and by integrating the non-rectified torque with respect to joint angle (i.e., "work score" in Nm-deg). The procedures provided objective quantifications of torque resistance, yielding two forms of objective rigidity scores [19,24]. The angular score has been shown to be a valid objective measure of rigidity that improves the sensitivity and reproducibility of assessment [24]. The higher the objective rigidity scores were, the more severe the rigidity was.

Results and Discussion

The baseline temporal and work scores for Case #1 were 0.45 Nm-sec and 18.32 Nm-deg (Figure 1). Immediately after cooling intervention, rigidity scores decreased to 0.30 Nm-sec for temporal score and to 11.93 Nm-deg for work score, respectively. At 30-min Posttest, rigidity scores showed increases to 0.36 Nm-sec and 15.77 Nm-deg, compared to Posttest. However, the scores remained smaller than the Pretest measures (Figure 1). In Case #2, baseline scores were 0.11 Nm-sec and 3.13 Nm-deg. Slight increases were observed for temporal score (0.17 Nm-sec) and work score (3.88 Nm-deg) at Posttest measures. There were reductions for both temporal and work scores (0.11 Nm-sec and 2.41 Nm-deg) at 30-min Posttest (Figure 2). The work score at 30-min Posttest was lower than that of Pretest (Figure 2B).

The present study reported potentially beneficial effects of cooling intervention on managing rigidity in PD. While the concept of cooling interventions is not completely novel to the realm of physical therapy, and previous studies have examined the effects of cooling on reducing spasticity, its application in treating parkinsonian rigidity has never been studied. The current case report is the first study describing the effect of cooling in managing parkinsonian rigidity.

Several studies have shown that rigidity is attributed to exaggerated long-latency stretch reflexes [7-10]. It has been reported that cooling therapy (or cryotherapy) can decrease the sensitivity of muscle spindles to stretch, and alter the stretch reflexes in spasticity [13-15,25]. In addition, there has been long-standing reports that when nerve temperature is decreased, nerve conduction velocity is decreased following cryotherapy [26,27].

Results obtained from this report showed that Case #2 appeared to be less responsive to cooling intervention. During participation, patients were instructed not to change the schedule for dopaminergic medication. It is noted that it generally takes about 30 minutes for dopaminergic medication to take an effect, and reach its peak level approximately 60 minutes after taking medicine. Also, the timeline for medication effect can vary from one to another patient. In this report, the baseline or pretest measures for the two patients were assessed 60 and 85 minutes post-medication, respectively. Medication is expected to influence the study findings. It is highly likely that medication might have diminished the therapeutic effect of cooling intervention on rigidity. On the other hand, this may explain the differences observed between the two patients.

It is acknowledged that the study has limitations. Results were based on a small number of participants. Case reports cannot establish any causal relationship. Further, the protocol was performed in the state of On-medication that can potentially confound the outcomes of the study.

Conclusion

This case reports provided preliminary results with respect to the potential benefits of cooling for parkinsonian rigidity. The study is of novelty since there has been no previous study that has examined the efficacy of cooling intervention in this patient population. Further, this report is clinically significant, because rigidity impairs patients' motor function and quality of life by limiting mobility and impeding balance and gait [28,29]. A temporary 30-min reduction in rigidity provides a practical and realistic duration for patients to participate in physical activity and exercise. Accumulating evidence indicates that exercises are beneficial to slowing disease progression and improving function and quality of life in patients with Parkinson's disease. Cryotherapy can be applied with an ease of use and minimal side effect. Future study may be conducted to incorporate a temporary withdrawal of medication (i.e., Off-medication) to eliminate any confounding influence. Future research utilizing an experimental design performed on a larger sample size of patients and comparison control group is warranted for further investigation on this topic.

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