Brake Response Time in Diabetic Patients with Lower Extremity Neuropathy

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Statement of Purpose and Literature Review

The presentation of diabetic neuropathy is as a symmetrical sensorimotor polyneuropathy preferentially affecting the lower extremities. The most apparent effects of this occur within the sensory system and contribute to the development of pedal ulcerations, lower extremity infection, and both minor and major limb amputations. However, involvement of the motor system also carries the potential for significant clinical pathology. Lower extremity weakness, muscular atrophy, slowing of movements, unstable gait and an increased frequency of falls have all been associated with diabetic motor neuropathy. Additionally, and distinct from the lower extremity, general auditory and visual reaction times have been demonstrated to be impaired in the presence of diabetic neuropathy.

Further, the effect of lower extremity pathology and surgical intervention on driving function and brake response times has been a topic of contemporary interest within the medical literature. Several authors have published general guidelines about the return to driving following elective and non-elective lower extremity surgery, while others have specifically studied the effect of chronic musculoskeletal lower extremity pathology and immobilization devices on driving outcomes. Despite this, we are unaware of any specific analysis into the effects of diabetic neuropathy and diabetic foot disease on driving parameters.

The objective of this investigation was to assess brake response times in diabetics with neuropathy. We aimed to determine if diabetics with neuropathy have slower brake reaction times than normative values and published safety thresholds.

Methodology

The braking performance of participants was evaluated with a computerized driving simulator (Outpatient Simple Reaction Time; Noldus Information Technology, Inc., The Hague, The Netherlands) which has previously been used to evaluate driving reaction times in the setting of lower extremity impairment. The simulator consists of a laptop computer, steering wheel, accelerator and brake pedal system (Figure 1). Participants were seated in a comfortable position with the seat adjusted to ensure that the accelerator pedal and steering wheel was aligned for individual comfort. The accelerator pedal was initially depressed with their right foot until a constant speed was maintained. Then, as a random time within 5 to 10 second windows, a red light was illuminated at the foot of the participant. Participants were instructed to depress the brake pedal as quickly as they could as a reaction to the red light. The time interval between the initiation of brake pedal depression was recorded as the brake response time.

Verbal instructions to use the simulator were given and participants had the opportunity to undergo practice trials prior to actual brake response testing and they felt comfortable with the environment. The simulator utilized the same settings for each participant, with elimination of the fastest and slowest trials for each set prior to data analysis. The primary outcome measure was the mean brake response time from the eight recorded trials.

There are some published reports with respect to normal and abnormal brake response times. Although a meta-analysis has demonstrated a relatively large range in reported brake response times, the National Highway Administration have reported a cut-off threshold for potentially unsafe brake response times at 0.700 seconds and an associated frequency of approximately 95.0%. Based on this work, we chose to use a threshold of 0.700 seconds as our metric for clinically impaired brake response times in this investigation based on these studies. We considered brake response times less than 0.700 seconds to represent normal brake response times.