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Review

Driving in Parkinson's Disease

Parkinson Hastalığında Sürücülük

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Summary

Even though drivers with Parkinson's disease (PD) are considered at higher for accidents due to associated visual, cognitive impairments as well as sleeping and movement disorders, no epidemiologic relationship between PD and accidents has been established. However, drivers with PD have been found to cease driving earlier than healthy controls of similar age. The medical diagnosis or the physician's evaluation alone is not enough to decide driving fitness in drivers with PD. Evaluation of movement, cognitive and visual skills and traffic and driving simulation tests help to assess driving performance, however there are no well-established and standardized methods and guidelines to determine driver fitness in PD in Turkey or worldwide. Components of driving skills and evaluation of driving performance in PD along with the description of the status of driving research and assessments in Turkey and proposals to advance driving assessment in Turkey will be discussed in our manuscript. Developing a standardized evaluation methods and a multidisciplinary decision process for the patients with a neurodegenerative disease is very important to maintain their safe vehicular mobility for a long time. (Turkish Journal of Neurology 2014; 20:64-71)

Key Words: Parkinson's disease, driving, driving tests

Özet

Parkinsonlu sürücüler yaşadıkları görsel, bilişsel, uyku ve hareket bozukluklarına bağlı olarak kazalar için daha riskli olarak düşünülse de, Parkinson hastalığı (PH) ile kazalar arasında açık bir epidemiyolojik ilişki henüz ortaya konamamıştır. Ancak, kontrol grubuna göre daha erken sürücülüğü bırakma eğiliminde oldukları saptanmıştır. Salt tıbbi tanı veya doktor değerlendirmesi PH'da sürücülük yeterliliğine karar vermede yeterli değildir. Hareket, bilişsel ve görsel yetenekleri değerlendirme, trafik ve sürüş simülasyon testleri PH'da sürücülük performansını anlamaya yardım ederler. Ancak bunun için bizim ülkemizde ve tüm dünyada yerleşmiş standart bir yaklaşım henüz yoktur. Bu yazıda sürüş yeteneğinin bileşenleri ile PH'da sürücülüğün değerlendirilmesi çalışmalar eşliğinde tartışılacak ve bizim ülkemizdeki durum ve iyileştirilebilmesi için neler yapılabileceğinin üzerinde durulacaktır. Nörodejeneratif bir hastalığın varlığında hastanın hareketliliğini ve özgürlüğünü mümkün olan en uzun süreç boyunca temin etme noktasında, standart test yöntemlerin kullanılması ve belli uzmanların oluşturduğu bir ekibin verdiği doğru değerlendirme ve kararlar çok büyük önem arz etmektedir. (Türk Nöroloji Dergisi 2014; 20:64-71)

Anahtar Kelimeler: Parkinson hastalığı, sürücülük, sürüş testleri

Introduction

Driving is an important daily activity that is required for personal mobility and independence. The number of people in society affected by a chronic systemic disease who are over 65 years of age has been increasing. In elderly people with health problems, particularly those with neurodegenerative disorders such as Parkinson's or Alzheimer's disease, driving capacity may be disturbed or terminated (1,2). Even though the most salient signs are of motor origin, Parkinson disease (PD) may affect anatomical areas ranging from brainstem to neocortex and neurotransmitter systems, disturbing cognitive, visual, sleep-related and autonomic functions (3,4,5).

The goal with drivers with PD is to preserve the patient's mobility and independence while maintaining traffic security and

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preventing accidents (1,6). The institutions that issue the driver's license often consult to healthcare workers about the potential risks associated with an affected individual's driving (7). A single physician's judgment and conviction on this matter may not provide an adequate assessment (8). In addition, holding a single physician responsible for such a decision may disrupt patient-doctor relationship due to the patient's voluntary omission of certain clinical information (9). Therefore, healthcare workers need fair, objective criterion when cooperating with authorities on assessment of a patient's suitability for driving (1,7,10).

In retrospective and cross-sectional (7,11,12,13,14,15,16) and also in prospective (17) studies, Parkinson patients showed worse performance in traffic (17,18,19,20,21,22,23,24,25,26) and simulation tests (27,28,29,30,31,32) and had their driver statuses revoked. Despite the limitations of the retrospective studies, it was reported that Parkinson patients had higher rates of accidents and error rates (13,15). Population-based, prospective controlled or epidemiological studies on this topic, however, failed to confirm the increased accident rate of Parkinson patients (7,17).

The aim of this paper is to investigate the implications of the PD-related lesions in driving behavior and to predict the potential for rehabilitation further ahead of time. In this paper, we try to answer these questions:

1. Which measurement methods should be employed in a battery for driving safety?

2. What metrics should be used in these assessments?

3. What are the effective ways of administering these assessments?

4. In what frequency do drivers need to be re-evaluated for their suitability to drive?

Cognitive Models of Driving Behavior

A driver's sociodemographic and clinical characteristics, environmental conditions, vehicle status and the patient's attentional state are taken into consideration when a patient's driving performance is evaluated (33).

First, factors related to driver will be discussed. Michon described three levels of cognitive control in driving behavior (strategic, tactical and operational) (7,34,35). Driving in inclement weather or route selection in highway/urban areas are strategic behaviors in driving. Speed adjustment according to the traffic flow and sign, inter-vehicle distance adjustment and overtaking are tactical behaviors because they require an active use of visual cues and prompt decision-making (36). Staying in the lane, keeping a safe distance and reacting to possible dangers are operational behaviors since they are executed automatically with minimal conscious effort (35). The strategic decision to drive on a snowy day, combined with high speed or tailgating creates compromising situations for the driver.

The decline in decision-making capacity due to the executive function impairment may facilitate faulty strategies and judgment such as driving in challenging conditions or making difficult or inappropriate maneuvers. Impairments in attention, visual perception, memory, executive functions, motor speed and self-evaluation may promote driving errors by preventing safe operation of the vehicle in the event of sudden dangers.

Numerous researchers showed brain activation during driving in simulations using MRI, PET or SPECT imaging (37,44). These studies showed activations in parieto-occipital cortices, and the connection between perceptual and motor cortical areas and cerebellum during driving as compared to resting condition (43,45). Stereotyped behaviors such as turning on the ignition, making turns, reversing and stopping the vehicle engaged premotor, parietal and cerebellar areas; unpredictable and dangerous events like going off the road and obstacle avoidance, however, activated medial premotor cortex, insula, lateral occipital and parietal areas. In addition, planning consequent moves and following vehicles engage more the superior parietal, lateral occipital cortices and evoke cerebellar activity. Right lateral prefrontal cortex is responsible for the perception and adherence to the traffic rules (43). Activation in the frontal, parietal, occipital and thalamic areas were shown to increase as a function of driving speed (37,38). Following an unknown course elicits activation in inferior frontal, middle temporal and occipital cortexes, cerebellum and parahippocampal gyrus (46). It was also found that accident rates in the driving simulations (38) and keeping a safe distance with the car in front were negatively correlates with the anterior cingulate activity (44). In a study by Maguire et al. on taxi drivers in London, it was found that hippocampus is detrimental in interpreting detailed spatial representations and allowing navigation and path finding in complex spatial layouts (47).

The effects of distractive behaviors such as talking on the cellular phone, talking to the passengers or eating on driving capability and brain activity were investigated by Just et al. in a functional MRI study. The drivers were asked to drive on a winding road while answering yes/no questions at the same time without any additional conversation. In these drivers, the vehicle control was markedly impaired and the parietal lobe activity was reduced by 37% in the functional MRI scan as compared to the condition where there were no distractions (4). Since these conversations can become disruptive especially in drivers with cognitive impairments, they might affect driving safety and performance negatively. Alcohol was also shown to impair hippocampus, anterior cingulate and dorsolateral prefrontal area activity, therefore impairing visual attention and worsening driving performance significantly (48).

Studies and Theories on Driving in Parkinson's Disease

Due to the complex nature of the driving behavior and PD, numerous assessments to allow comparison with control groups are needed to evaluate driving skills and possible outcomes. In a review article in published in 2012, after going over the literature to that date, Crizzle et al. reported the need for class 1, A level studies to develop an evidence-based evaluation guideline (49).

The studies included in this review used fully equipped cars in traffic tests, driving simulations and a clinical battery. The clinical battery included demographic properties, general medical and psychiatric status, sleep, quality of life, driving history and habits as assessed by Driving Habits Inventory, visual, cognitive and motor function evaluations. Contrast sensitivity, near and far vision acuity, spatial and action perception, visual processing speed tests and Mini-mental test and neuropsychological battery were used to assess low-level vision, visual attention, visual perception and cognitive functions (49,50).

Traffic tests are administered on patients when their drugs are in full effect for ethical reasons. There is no study comparing the driving performance with or without the drug. This contrast can only be made in the safe confines of the simulator environment. Simulators are useful in testing driving behavior in high-risk conditions whereas traffic tests in fully equipped cars allow for observations in routine driving conditions.

Even though the goal in driving studies is to predict, understand and prevent accidents, the applications in real life seem to be non-trivial (51). The information on real life accidents is often based on eyewitnesses and the driver's reports. Most traffic test studies report error type, frequency, locations and the severity. As an additional indicator, some studies use a criterion similar to traffic tests and indicate "safe or dangerous" and "acceptable or failing". Security errors such as traffic lane violations are frequent but low-danger errors sporadically result in accidents. Standard traffic test may give erroneous results due to the unreliability of driver assessment, the tests' bad design or the driver's safety (52,53,54). Uç et al. found a mild association between high error rates and future early-termination of driving (17). In addition, traffic tests have not been validated for their predictive power for future actions.

Driver Tests

1. For State Issued Licenses

Experts evaluate driving performance of a prospective driver from certain aspects and decide whether they can safely operate a motor vehicle (52). These evaluations involve elements such as parking, making turns using certain maneuvers, traffic signs and stop signs. These standardized tests were developed to assess whether a person should be given a drivers license and not to evaluate the driving quality of elderly people or people with debilities due to health conditions.

2. Experimental Traffic Tests

These tests are similar to the state traffic tests but they are developed specifically for obtaining scientific information on driving performance and safety of certain demographic and clinical groups. They can be conducted in traffic (55) or public access areas (25,56,57) using certain signs, distances and durations. Experimental traffic tests are sometimes conducted by the driving instructor in order to evaluate certain aspects of driving. Individual differences in interpreting the outcome of the experiments can be avoided by the use of quantitative tools such as electronic sensors or hidden cameras. Audio-visual recordings of the driver during the trip can be replayed to reveal performance details and any distracting elements like conversations. Studies using traffic tests and their results are reported below.

Heikkila et al. compared 20 PD patients with age and sex-matched controls in terms of driving performance in traffic and found that patients and even neurologists overestimate their driving performance (22). All participants completed the neuropsychological battery that tests for attention, concentration, visual perception, response selection and time, and information processing. Self-assessment forms for driver's performance, the tests conducted by a neurologist or psychologist, interviews and driving test conducted by a driving instructor were used to compare Parkinson patients to healthy controls and the patients were seen to perform worse on both the neuropsychological tests and traffic tests. Driving instructors found 35% of the PD patients to be dangerous drivers while the neurologists and drivers themselves did not consider their driving as dangerous. While there was a significant relationship between the points given by the driving instructor and the predictions of the psychologist, there were no relationships between the neurologists' prediction. All members of the control group, on the other hand, were found to be safe drivers by all raters. For both control and the patient group, there was a very strong relationship between the performance in the neuropsychological test battery and the driving performance. Disease duration, motor stages of the disease or Mini-mental state examination results were not associated with the driving performance of the Parkinson patients, but the errors observed during driving test were found to be related to the information processing. Sluggish visual information processing, age and L-dopa dosage explained 67% of the variance in the traffic safety violations (22).

A study by Radford et al., which did not include a control group, applied an off-road battery and traffic tests to 51 Parkinson patients and 6 patients were found to be dangerous drivers according to the instructor due to the severity of their errors. There was a significant relationship between the driving performance expressed in points, and attention, memory and information processing performance (58).

Grace et al., compared the traffic safety rating of 21 PD patients with an equal number of Alzheimer patients and controls and found that Alzheimer patients were worse drivers. When compared to other groups, PD patients had difficulty in maneuvers requiring neck mobility. The driving performance of the PD patients were found to be associated with their Hoehn-Yahr (HY) stage, Rey Osterrieth complex figure drawing test, tracing, Hopkins verbal learning test scores but not associated with Unified Parkinson's disease rating scale (UPDRS) and total motor scores (21).

Wood et al. evaluated 25 PD patients with 21 age-matched controls in terms of driving performance in open traffic, and found PD patients to be significantly dangerous drivers. More than half of PD patients were at a level that would fail a state-regulated

driving test. While there was a meaningful relationship between the driving safety scores and disease duration, there were no relationship with the UPDRS scores which indicated their state as "open". Parkinson patients made more errors with lane changes, lane maintenance, blind-spot checks, reversing, parallel parking and traffic light intersections as compared to the control group. The instructors had to interfere more with these patients in order to prevent accidents (25). Motor performance, contrast sensitivity, cognitive function tests showed high sensitivity in determining whether the patients would succeed or fail a driving test.

In a study by Amick et al. that did not include a control group, 25 PD patients without dementia were tested and 11 of them were found to be either borderline or dangerous drivers. In addition, this study also found a relationship between bad driving performance, and contrast sensitivity, visuo-spatial processing and attention. Executive functions and visuo-spatial functions were also found to be the biggest risk factors (59).

Classen et al. compared 19 PD patients with 104 healthy controls in a traffic test and found that 42.1% of the patient group and 21.2% of the control group failed the test. Among many other variables, they found that especially the visuo-spatial test had the strongest predictive relationship with the failure in the test (18).

Uç et al. compared 84 PD patients who are licensed active drivers with 184 controls in both urban and countryside road using fully equipped vehicles. Generally PD patients were found to be worse than the controls but they also showed a large variability, some of them being completely normal drivers. Lane violations were found to be the most common one of the errors. Old age, loss of visual acuity, sluggish visual processing speed, attention, visual memory and visuo-spatial deficits were the risk factors for high security error rates. In the follow-up of the study, 38% of the PD group and 68% of the control group came back for the repetition of the traffic tests. While PD patients who came for the follow-up had lower error rates than those who did not, there was no such difference within the control group. When compared to the control group, PD group showed higher total error rates. Visual attention, processing speed and total cognitive state were important factors for the drivers with PD. In the same study, driving tasks with navigation, visual search and audio-visual distractors were used to compare PD patients and controls. It took longer for the PD patients to follow a path and they made more errors (57).

Using a specially equipped automobile (behavioral and positional trackers, speed sensors etc.), the drivers were asked to indicate whether they saw certain targets and traffic signs along the 4-lane road in order to test their visual search and detection skills. Drivers with PD detected much fewer targets and traffic signs and made more errors compared to the control group. In PD, the biggest predictors of detecting targets and traffic signs were their visual information processing speed and visuo-spatial performance. Trail-making test was found to be the only factor for the security errors independent of the motor functioning.

Another study with the same PD patients and control group investigated the importance of visual-verbal distractors when cruising on a 4-lane highway. Parkinson patients were affected more by the distractors even though they drove slower, made more security errors and had worse speed regulation. Cognitive flexibility, verbal memory, balance control and day-time drowsiness predicted decreased driving performance due to attention loss in the PD group (23).

Devos et al. compared 40 PD patients and 40 age and sex-matched controls using a off-road battery and driving simulation test. Among the PD patients, 72.5% were found to be "okay to drive without restriction", 27.5% were found to be unsuccessful (29). A follow-up study using 104 actively driving PD patients conducted six years after the first study showed that this ratio was 65% to 35% (61). The biggest causes of failure were the faulty left turn maneuvers, poor lateral control of the vehicle during low speeds and inconsistent speed regulation at higher speeds. A detailed investigation showed that the failing group had deficits in visual acuity, executive functioning, attention and motor functioning along with postural imbalance/gait disorders depending on the subtype of the disease (61). Since individual testing would be difficult, Devos et al. devised a simple scanning battery for policlinic use. As a result, a battery that consisted of disease duration, contrast sensitivity, Clinical Dementia Grading, and UPDRS motor section constituted the best clinical scanning battery by classifying PD patients' driving success with 90% accuracy. The addition of simulator results further increased the accuracy (62).

3. Driving Simulation Tests

Driving simulations aim at investigating the types of driving behavior that is too dangerous to test in real traffic in a controlled environment where the stimulating elements and response control can be maintained in a reproducible experimental condition (1). Among such simulation scenarios, intersections with unexpected dangers, car pursuit, passing, merging lanes, cell phone and the use of navigation device can be considered (30,63). The dependent variables in the driving simulations can be the presence of collision, obedience of traffic signals, sudden and gradual braking, releasing the gas pedal on time and acceleration/deceleration (30).

Driving simulations vary in terms of moving versus stationary ground, interactivity, resolution and field of view. The ones with low sensitivity have non-interactive, video based desktop PCs without 3D graphics. Medium sensitivity simulations include a full size automobile interior but they lack a moving ground. High sensitivity simulators are frequently capable of simulating elevation, left/right collision and rolling because of their moving ground. They are expensive systems that include 3D, multimodal, tactile, vibrating and vestibular indicators (1).

Even though real automobiles provide richer and more environmentally valid information about vehicle control during road tests, driving simulations may still provide complementary information. Since the drivers know that they will not get hurt in an accident happening inside the simulator despite the realistic emulation of a car's interior and driving conditions, their behaviors may show important differences (64).

Another limitation of simulator vehicles is adaptation syndrome called "simulator sickness" which resembles motion sickness. This condition is caused by the visual-vestibular mismatch in certain drivers and may affect performance or even render it impossible. Avoiding complicated scenarios, sudden, sharp maneuvers and pre-test practicing may prepare the drivers for the road test (1,65).

Despite all of its known limitations, driving simulation test is a fast developing field allowing the comparison of driving performances of different groups. In addition, the lack of standardization in the technical properties and test designs of the driving simulators may prevent comparison of the results. The use of driving simulations in the new driver education and the rehabilitation of drivers with health problems, such as PD, has been getting more common (1,65). Driving simulation studies in PD has been summarized below.

Madeley et al. compared 10 patients with 10 controls and found that the patients had worse steering control, longer reaction times and more red-light violations. In a similar study, PD patients were shown to violate red-lights at earlier ages compared to controls, had direction errors and longer reaction times (27).

The increased risk of accidents in PD has been proven in simulation studies. Zesiewicz et al. compared 39 PD patients with 25 healthy controls in a low sensitivity driving simulation and found that patients had more accidents. The accident rates correlated with the severity of motor degradation and Mini-mental test scores (32). Uç et al. tested a condition where the participants were following a car that made an unexpected stop at a green light, and found that people with PD rear-ended the car more often than the control group. Visual perception impairments, cognitive decline and UPDRS scores were risk factors for rear-ending (66).

People with PD may have increased risk in conditions where visibility is compromised, such as foggy weather or darkness. 67 licensed drivers with PD were compared to 51 controls in a simulation where the weather was foggy and there was a car at the intersection that is designed to cause an accident. Parkinson patients' vehicle control in the foggy conditions was weaker than the controls as shown by the lateral deviations and lane violations. Poor visibility conditions affected these variables more severely for PD patients compared to controls. People with PD had higher rates of collision at the intersection in the foggy conditions (76.1% vs. 37.3%). When compared to the controls, it was seen that PD group had longer reaction times for the sudden evasive reactions such as pushing the brakes. A multivariate analysis within the PD group revealed visual attention, cognitive state and UPDRS scores to be the primary determinants of poor driving performance in the bad visibility conditions. In the multivariate regression analyses, the most important factor was the decreased motion detection as measured by visual perception technique. In the multivariate analyses, the best predictors of the delayed reaction time were simple vision and finger tapping tests (30).

Uç et al. investigated the effects of the motor dysfunction during a task where 31 PD patients and 19 controls were asked to roll down the windows of the car they were driving on a country road in a simulation. People with PD completed the task more slowly, made more safety errors and loss control of the vehicle more often. The loss of visuo-spatial function and decreasing UPDRS daily life activities scores suggested that the decline in driving security was due to the attentional deficit in PD (31).

Driving in Real Life

There are no clear epidemiological findings on the accident risk for the PD patients (1). However, a retrospective cross-sectional study in a motor disorders center found that 20% of the PD patients stopped driving as a result of the disorder and their debilitation went higher as a consequence (13). More severe (HY stage 1) cases reported twice as more accidents compared to controls. Three times higher number of accidents were reported by the patients who had 23 or lower Mini-mental score.

A large-scale email and phone study in Germany showed that 82% of PD patients had licenses and 60% of them still drove (16). Among the ones who had a license, 15% got involved in at least one accident in the past 5 years, and 11% of them caused an accident. There was no control group for this study, but a qualitative comparison with the German population indicates that PD patients under 70 were much more likely to be involved in an accident. Accident risk increased for patients who had mild sleep disorders, increased daytime sleepiness scores and who reported "sleep attacks" during driving. The ones who stopped driving were frequently female and older with more severe or longer lasting disorders, or those with high sleepiness scale scores (16). Senility and disruptions in the daily activities were the most distinguishing clinical factors between active drivers and those who quit driving (12).

Singh et al. reviewed the records of 154 PD patients referred to Scottish Driving Evaluation Service by their GPs, specialists or Driving and Licensing Department over the course of 15 years (1989-2004). Out of 104 patients, 66% continued to drive but 46 of them needed to switch to automatic cars while 10 of them needed additional modifications. The predictors of the driving skill were age, severity of and duration of the disorder, accompanying conditions such as dementia, and brake reaction and timing in the simulation tests. There were no significant relationship between the dose of drug treatment and how long the patient had been driving (16).

In a prospective cohort study conducted by Uç et al., 106 PD patients who were active drivers at the time were compared to 130 controls and it was found that the patient group stopped driving earlier than the controls. It was 17.6% likely that the patients stop driving after 2 years of diagnosis while this likelihood was 3.1% for the controls. There were no difference between the groups in terms of the time and place of the first accident. The factors that determined the termination of driving in the PD case were advanced age, preference for another driver, previous history of accidents, the use of compensatory strategies, decreased driving frequency, visual and cognitive dysfunctions, increased error rates

in the traffic tests, and especially daily living activities score and total daily antiparkinson treatment dosage (17).

Limitations and Aims of the Studies

Even though there is an increasing number of studies on driving in PD, most of these studies are cross-sectional or retrospective without any control groups. The sample sizes in most of these experimental studies were between 20 and 50. In some studies, the sample size increased up to 80 people. Reliability and validity of self-reported questionnaires have not been established. In addition, there is no validation of the driving simulation tests as opposed to the performance tests conducted in areas closed to traffic. Off-road testing batteries used by different research centers have not been standardized. There are no established cut-off points that could be used to clinically determine suitability for driving. In addition, it is not practical to use these batteries in clinics or license issuing centers because of their long duration. Another very important issue is the lack of consensus on the frequency of re-testing. In conclusion, the aims of these studies were to suggest valid and safe tests that have high predictive power.

Psychiatric Character of Parkinson Disease, Treatments, Sleep Disorders and Driving

Parkinson disease is associated with psychiatric disorders such as anxiety, depression, apathy, hallucinations, psychosis and impulse control impairment. The effect of loss of impulse control on driving has been shown on general populations (67,68). Depression, apathy, hallucinations have been associated with termination of driving and accidents in elderly people (69). There is need for primarily cognitive and neuropsychological batteries, and secondarily simulation tests in order to delineate the effects of the psychiatric character of PD on driving.

There is limited number of studies on the effects of dopaminergic treatment methods such as Levodopa or direct agonists on driving. Uç et al. grouped PD patients into L-dopa only, L-dopa and dopamine agonist together and other treatments, and they failed to find any difference between the groups in terms of tracking and safety errors. While there was no relationship between daily L-dopa (mg) dose and experimental driving performance, it was found to predict the early termination of driving (17).

Since Frucht et al., reported "sleep attacks" and daytime sleepiness in PD patients using dopamine agonists such as ropinirole vs pramipexole, these side effects have been reported with all dopaminergic drugs used in the treatment of PD (70,71). Thirty two percent of PD patients had complaints of daytime sleepiness, 1-14% reported "sleep attacks and 1-4% of those reported sleep attacks during driving (72). There was no significant relationship between the daytime sleepiness inventory scores or risk of falling asleep during driving and the type of treatment. There was a significantly increased accident risk for moderate or more severe cases of PD, and those who have increased sleepiness. In a study that included 1625 patients in France, male sex, decreased daily living activities and high L-dopa daily dose had been listed as the risk factors for daytime sleepiness. There was a significant relationship between speed, attentional deficit in simulator and traffic tests, and increased sleepiness scores while there was no significant relationship between driving errors and other performance variables, and sleepiness.

What Can Be Done in Turkey to Evaluate and Improve Driving in Parkinson Disease

This issue is regulated by the "Regulations for the health conditions and medical examinations of driver candidates and drivers" legislature numbered 26301 from date 09.26.2006. First, all candidates must undergo a health examination conducted by a physician or a specialist. The 9th section of the regulation dictates that "those who have congenital or acquired paresis or paralyses of the central nervous system (affecting sensory, motor, coordination and balance) to the extent that will affect their driving behavior and traffic safety are not eligible to be licensed drivers. Those who have mild impairments can be issued a license at the discretion of the neurologist", which would leave the judgement to the neurologists. The 8th section of the same legislature states that these individuals may be given a specially equipped vehicle should they receive the approval of the physician. The tests required to assess the driving skills of these individuals, however, do not exist in our country. The aim should be to compile a battery of suitable tests by those who involved in testing –such as the neurologist, psychiatrist, psychologist, driving instructor and therapist and licensing authority- and to apply this battery to people with neurodegenerative diseases with frequencies ranging from 6 months to 2 years, providing the maximal daily life independence and freedom while avoiding safety hazards.

The methods used to assess driving safety in people with health problems and the requirements of reporting the results of these assessments to authorities vary in every country. Healthcare workers must educate themselves on providing information about drivers with debilitating conditions. Medical diagnosis or a physician's opinion by themselves are not sufficient to determine the adequacy of driving skills in PD. While motor, cognitive and visual abilities are good evaluations for driving safety in PD, there are no specific guidelines reported. Depending on the personal nature of the disease and its varied course, the individuals that need to be assessed should undergo a careful evaluation conducted by a driving rehabilitation specialist. Due to the variety and even conflicting results of the studies investigating the prediction power of certain tests, license issuing individuals and departments should exercise caution in determining whether these patients are eligible to be licensed drivers. Having the progressive nature of the disease in mind, the starting scores of the individuals at the onset of the disease should be determined and they should be re-evaluated periodically to ascertain the maximum duration of safe driving.

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