Pesticide Exposure and Its Association to Parkinson's Disease Development: An Intrinsic Case Study in India

Aiswarya Anilkumar[1], Geetha Veliah[2], Kalpana Kosalram[2]

[1]Epidemiologist, Indian Institute of Public Health, Hyderabad
[2]Associate Professor, Division of Health Communications, SRM School of Public Health, SRMIST

Corresponding Author: Aiswarya Anilkumar

ABSTRACT

Parkinson's disease is a neurodegenerative disorder that affects a large number of people all around the globe. Though the causation of Parkinson's disease is not well established, findings have advocated multifactorial pathogenesis involving genetic susceptibility, ageing, and possible exposure to certain chemicals. Epidemiological and experimental studies conducted have suggested an association between exposures to pesticides and increased risk of Parkinson's disease development. A 59-year-old man diagnosed with Parkinson's disease for 18 years, residing in Ernakulam district of Kerala, India was assessed as Stage 2.5 (Mild bilateral disease with recovery on pull test) by Hoehn and Yahr staging scale and also reported to have no other co-morbidities. A Berg Balance score of 37 classified him into a medium fall risk category and an ABC score of 70.62% categorized him under a moderate level of functioning. This is the first self-reported case of paraquat exposure and Parkinson's disease development in Kerala. The respondent was a farmer by occupation and reported to have used gramoxone pesticide containing paraquat for pineapple farming for more than two decades. The report on this intrinsic case study focusing on balance, paraquat exposure, disease development, and severity is unique. This would help in further research expansion on understanding the risk factors for disease development. This could serve as a regulatory basis to understand paraquat levels of concern, human levels of exposure, and its importance on neurotoxicity. This case study would also help in creating awareness regarding the harmful effects of paraquat usage and risk for Parkinson's disease development.

Keywords: *Paraquat, Parkinson's disease, Berg Balance Scale, ABC Scale, Hoehn and Yahr staging*

INTRODUCTION

Parkinson's disease (PD) is a neurodegenerative disease characterized by the progressive depletion of dopaminergic neurons in the substantia nigra that manifests clinically as resting tremor, rigidity, postural instability, and bradykinesia. [1] Though the causation of Parkinson's disease is not well established, findings have advocated multifactorial pathogenesis involving genetic susceptibility, ageing, and possible exposure to certain chemicals. [2] Epidemiological and experimental studies conducted have suggested an association between exposures to pesticides and increased risk of Parkinson's disease development. [3] Paraquat (1, 1′-dimethyl-4, 4′-bipyridinium dichloride) is a commonly used weedicide in Asia and was first synthesized in the late 19th century. [4,5] This has become one of the most extensively used herbicide because of its rapid contact-dependent killing of weeds and plants and its timely inactivation upon reaching the soil. Paraquat is a vital member of the bipyridylium family of an extensive variety of herbicides, is commonly used to control pests in several crops, such as soybeans, sorghum, sugar cane, cotton, corn, apple, and pineapple. [2]

In the year 1983, an association between pesticides and Parkinson's disease was first suspected when the chemical 1-methyl-4-phenyl-1, 2, 3, 6- tetrahydropyridine (MPTP), which has a chemical structure analogous to the herbicide paraquat, was detected to cause acute Parkinsonism. Ever since this discovery, exposure to pesticides and consequent development of Parkinson's disease has been studied intensively. [6]

Description of the case

A 59-year-old man diagnosed with Parkinson's disease for the past 18 years, residing in Ernakulam district of Kerala, India was interviewed using a semi-structured questionnaire to understand the demographic details, risk factors, disease staging, balance level and the level of functioning. The respondent was a farmer by profession, married, and lived with his family. He reported that he had no co-morbidities apart from PD and recurrent falls were reported after the diagnosis of the disease. The respondent had no family history of Parkinson's disease. The severity of the disease was evaluated using the Modified Hoehn and Yahr scale, a widely used clinical rating scale. The scale defined the broad categories of motor function among Parkinson's patients. [7] The patient was assessed as Stage 2.5 (Mild bilateral disease with recovery on the pull test). The balance assessment was done using a five-point scale ranging from 0-4 called the Berg Balance Scale. The scale comprised of 14 tasks related to movements of daily living such as transfers, turns, and balance. It is scored from 0 to 56 points. The scores are categorized as 0-20 for high fall risk, 21-40 for medium fall risk, and 41-56 for low fall risk. [8] A Berg Balance score (BBS) of 37 classified him into a medium fall risk category. The Berg Balance Scale and the Modified Hoehn and Yahr scale has been validated across many studies and their correlation has also been established. Fear of fall among the Parkinson's patients was evaluated using an eleven point self-administered Activities-Specific Balance

Confidence (ABC) scale which also measures the level of physical functioning. The rating consists of whole numbers (0-100) for each item. A score of less than 50% categorized them as low level of functioning, 50-80% as a moderate level of functioning, and greater than 80% to be a high level of functioning. [9] The respondent secured an ABC score of 70.62% categorizing him under a moderate level of functioning. He reported having attended yoga sessions in the past and is under PD medications namely Ropark, Rasalect, Tidomet, and Pacitane. The respondent was a farmer by occupation and self-reported to have used Gramoxone pesticide containing paraquat for pineapple farming for more than two decades. He claimed paraquat was used extensively since it was cheaper and weeds could be controlled with lesser effort. Apart from the clinical reporting, the patient seemed unfortunate about the early onset of Parkinson's disease and self-reported a decreased quality of life.

DISCUSSION

To our knowledge, this is the first self-reported case of pesticide exposure among a Parkinson's disease patient with a moderate level of functioning categorized by the ABC score and a berg balance score of 37 classifying the patient under medium fall risk. Research studies have shown that occupational usage of the highly toxic chemical paraquat poses a threat to the human community and has shown to increase an individual's risk of Parkinson's disease. [5] The self-perceived association between paraquat usage and early onset of Parkinson's disease at the age of 41 substantiates the association between the pesticide usage and disease development. Paraquat in particular has always been a flag of concern regarding the association between PD onsets. The respondent was a farmer by occupation and has reported the extensive usage of paraquat containing pesticides for his crops before the onset of the disease. According to a report on the "*Conditions of paraquat use in India,*"

farmers have reported its usage from once in two weeks to once in a year. The study shows that there was no spraying calendar and paraquat was applied whenever weed intensity reached problematic levels. [10] The disease onset despite no family history in this case then is attributed to environmental exposure considering the pathogenicity.

The respondent mentioned the inappropriate packaging and distribution of pesticides in polythene covers. Decanting and selling paraquat dichloride in refill bottles, as well as in plastic carry bags, were noted among all the retailers as per a recent report. This further helps us understand the hazard that is being posed on the farmers. The pesticide is still used illegally in different parts of the country. [11] Paraquat distribution, sale, and use were stopped in Kerala since 2011 due to its potential to cause severe health implications. Many countries have banned paraquat due to its toxicity and others have established restrictive measures. (2) In many parts of India, the decanting and selling do not follow the required safety precautions as per The International Code of Conduct on Pesticide management. [11] The early onset of Parkinson's disease has tremendously deteriorated the balance level and level of function, as can be reflected from the scores evaluated. Longer years of exposure to pesticides indicated direct exposure to be more significant than farming as a risk factor. [12] The respondent's self-reporting on paraquat exposure can be considered highly appreciable despite his minimal knowledge of paraquat's association with Parkinson's disease inception. Retrospective self-reporting of exposure is considered the most common method for the estimation of pesticide exposure. This helps in understanding the association between the risk factor and the disease condition. [6] Causality can be established through a prospective observation starting from exposure to a risk factor to the occurrence of disease.

For the past few years, Pesticide Action Network and Berne Declaration have been requesting governments for a global ban on paraquat and also calling on the industry to prohibit production and sale of this highly hazardous pesticide. The product is banned in many countries including the African and Asian countries and the European Union but is still widely used in many developing countries leading to poisoning. [10] Several evidences from the literature have evaluated the association between environmental exposure and Parkinson's disease. [2,13] The respondent also reported usage of pesticide on pineapple farming, a crop that is not approved for paraquat usage as per the Central Insecticide Board and Registration Committee. This further supports the evidence for establishing the associations. [10] Reports have also suggested farmers reporting ill effects after exposure with paraquat. [10] Lack of awareness of the harmful effects and inappropriate usage further aggravates the situation.

This intrinsic case study focusing on balance, paraquat exposure, disease development, and severity is unique. This would definitely help in further research expansion on understanding the risk factors for disease development. This could serve as a regulatory basis to understand paraquat levels of concern, human levels of exposure, and its importance on neurotoxicity. [2] Further epidemiological and experimental studies could be conducted to establish a causal association between paraquat exposure and Parkinson's disease development. This unique case study would also help in creating awareness regarding the harmful effects of paraquat usage and risk for Parkinson's disease development. Awareness should be created regarding the harmful effects of this toxic chemical and should educate the users on the appropriate techniques for a harmless usage where and when required. A systematic understanding of pesticide exposure to Parkinson's disease development is vital to enhance our understandings into the perspective on the impact of environmental exposure on neurodegenerative diseases. [3] The evidence

reported in this case study would provide a benchmark in understanding paraquat exposure and its association along with the severity of disease staging, balance, and functionality.

Abbreviations
PD: Parkinson's Disease
BBS: Berg Balance Score
ABC: Activities-Specific Balance Confidence

REFERENCES
1. Hancock DB, Martin ER, Mayhew GM, Stajich JM, Jewett R, Stacy MA, et al. Pesticide exposure and risk of Parkinson's disease: A family-based case-control study. BMC Neurol. 2008;8:1–12.
2. Vaccari C, El Dib R, de Camargo JL V. Paraquat and Parkinson's disease: A systematic review protocol according to the OHAT approach for hazard identification. Syst Rev. 2017;6(1):1–8.
3. Cheng Y, Chou W, Yang Y et al. PBPK / PD assessment for Parkinson's disease risk posed by airborne pesticide paraquat exposure. Environ Sci Pollut Res Int. 2018 Feb; 25(6): 5359-5368.
4. Indira M. Outcome of Paraquat Self-poisoning a Case series. Am J Intern Med. 2015;3(6):1.
5. Reczek CR, Birsoy K, Kong H, Martínez-Reyes I, Wang T, Gao P, et al. A CRISPR screen identifies a pathway required for paraquat-induced cell death. Nat Chem Biol. 2017;13(12):1274–9.
6. Rugbjerg K, Anne Harris M, Shen H, Marion SA, Tsui JKC, Teschke K. Pesticide exposure and risk of Parkinson's disease - a population-based case-control study evaluating the potential for recall bias. Scand J Work Environ Heal. 2011;37(5):427–36.
7. Bhidayasiri R, Tarsy D. Movement Disorders: A Video Atlas. 2012;4–6. Available from: http://link.springer.com/10.1007/978-1-60327-426-5
8. Instructions G. Berg Balance Tests and Rating Scale. :2–5.
9. Moore, D. S., Ellis, R., Kosma, M., Fabre, J. M., McCarter, K. S., & Wood RH. The Activities-specific Balance Confidence (ABC) Scale. Res Q Exerc Sport. 2011;50(1):545–54.
10. Kumar D. Conditions of Paraquat Use in India. 2015. 1–32 p.
11. To S. Paraquat Dichloride Retailing in India : a Case Study From West Bengal a Sequel To ' Conditions of Paraquat Use in India ' 2015. 2017;(April).
12. Gupta V, Garg RK, Pant KK, Khattri S. A study on risk factors for Parkinson's disease in Indian population. Bioinformation. 2014; 10(6): 342–6.
13. Priyadarshi A, Khuder SA, Schaub EA, Priyadarshi SS. Environmental risk factors and Parkinson's disease: A metaanalysis. Environ Res. 2001;86(2):122–7.

How to cite this article: Anilkumar A, Veliah G, Kosalram K. Pesticide exposure and its association to Parkinson's disease development: an intrinsic case study in India. Int J Health Sci Res. 2020; 10(9):232-235.

******