

# EXOSOME-RICH MESENCHYMAL STEM CELL SECRETOME IMPROVES SYMPTOMS FROM PARKINSON'S DISEASE: A CASE SERIES

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- Background:** Parkinson's disease (PD) is a progressive neurological condition that primarily affects the central nervous system. It causes neurons to eventually degrade, leading to muscle tremors, rigidity, bradykinesia, impaired balance, and mask-like facies, among other symptoms. A combination of levodopa and carbidopa is the most common treatment for PD, though they are also given separately. These treatments have significant side effects, including headache, dizziness, nausea, somnolence, loss of appetite, diarrhea, constipation, and dyskinesia, which further exacerbate the already present PD symptoms. No disease-modifying treatment exists.
- Objectives:** Mesenchymal stem cell (MSC) secretome refers to the molecules secreted by stem cells during expansion in culture, which can include growth factors, cytokines, and exosomes. They have shown efficacy in models of PD in numerous preclinical studies and could provide an alternative, minimally invasive, and potentially disease-modifying treatment for PD. We hypothesized that secretome treatment via intranasal instillation would decrease PD symptoms and possibly be disease modifying.
- Study Design:** Patients diagnosed with PD were enrolled in the trial and received umbilical cord-derived MSC secretome (AlloEx Exosomes®) intranasal installations over a 2-day period.
- Setting:** All patients were treated in our treatment facility located in Antigua.
- Methods:** Treatment was repeated if desired by the patients at a minimum of 2-month intervals. Efficacy was measured using the Parkinson's Disease Questionnaire (PDQ-39) rating, electroencephalogram (EEG) tests, and patient reports.
- Results:** Nineteen patients were enrolled in the trial and received a total of 40 doses throughout the treatment. There were no adverse events from treatment. Two patients reported no improvement, 2 patients had transient improvement, while the remaining patients saw a significantly maintained decrease in symptoms with follow-up of up to one year. Average combined PDQ-39 scores decreased with each treatment, indicating an increase in the patient cohort's quality of life. Improvements were seen in the patient's EEG results, tremors, sensory impairments, bladder/bowel dysfunction, and sleep quality.
- Limitations:** Limitations of the study included a short follow-up length that limited the ability to determine if the treatment was disease modifying.
- Conclusions:** Intranasal MSC secretome installation is a safe method that is consistently effective in reducing Parkinson's symptoms and may represent the first-identified PD disease-modifying treatment.
- Key words:** Exosomes, secretome, Parkinson's disease, mesenchymal stem cells, intranasal, disease-modifying treatment, case report

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## BACKGROUND

Parkinson's disease (PD) is a common neurodegenerative disease with prevalence increasing with age. One percent of the population older than 60 and 4% over 80 years old are thought to be affected (1). There are an estimated 1.2 million cases in the United States. PD is characterized by a wide variety of motor and nonmotor symptoms, including tremors, bradykinesia, rigidity, postural instability, cognitive abnormalities, and sleep disorders (2-4). Patients suffer from regular falling, visual hallucinations, cognitive decline, and the need for residential care within 5 years before death on average (5). Motor neuron abnormalities of PD include neuronal loss in the pars compacta of the substantia nigra, as well as nigrostriatal dopaminergic degeneration (6). Additionally, Lewy bodies developed from a misfolded  $\alpha$ -synuclein protein, associated with the synuclein alpha (SNCA) gene, are a major component of PD (7,8). Risk factors for PD include pesticides and head trauma. There is an association with the SNCA, leucine rich repeat kinase 2, and parkin RBR E3 ubiquitin protein ligase genes (9,10).

## Treatment

Currently, there are only symptomatic treatments for Parkinson's disease (3,11). Levodopa is the most common treatment, with nearly all PD patients taking it (12,13). Levodopa is an immediate precursor to dopamine and can cross the blood-brain barrier (BBB), allowing depleted dopaminergic neurons to produce more dopamine, thereby alleviating symptoms (12,14). Carbidopa, which slows levodopa metabolism, thereby increasing levodopa availability in the brain, is typically paired with levodopa (15). Nausea is a common side effect of levodopa, which can be lessened by carbidopa, with other side effects, including hallucinations and delusions, limiting the doses given to patients (12,15). Levodopa consumption may also lead to levodopa-induced dyskinesia, a set of involuntary tremor-like movements, further contributing to the progression of PD (13,14,16,17).

## Exosomes

We have identified 41 preclinical studies, which have shown safety and efficacy with intranasal exosome-secretome treatment. Exosomes have been shown to cross the BBB in murine models of PD and can reach the substantia nigra due to their nano size (18-20). Additionally, exosomes have been shown to reduce neuronal loss

and apoptosis in the substantia nigra (18,21,22), repair nerve injury and reduce inflammation around dopaminergic neurons (24,25), and are conducive to generation of dopaminergic neurons, improving recovery (3,25-28) in murine models.

## METHODS

### Inclusion Criteria

Patients needed a physician-verified diagnosis of Parkinson's disease. Patients must have been 18 years old or older, cancer free, not pregnant, and capable of informed consent.

### Patient Cohorts

Nineteen patients with Parkinson's disease were selected for the trial. All patients were treated in our treatment facility located in Antigua. Patient demographics can be observed in Table 1.

### Objectives

The primary study objectives were demonstration of safety through observation of adverse events, and measurement of efficacy using the Parkinson's Disease Questionnaire (PDQ-39) rating, electroencephalogram (EEG) tests, and detailed interviews with patients.

### Exosomes

All patients were treated with the umbilical cord-derived mesenchymal stem cell (MSC) secretome known as AlloEx Exosomes<sup>®</sup> from Vitro Biopharma ([www.vitrobiopharma.com](http://www.vitrobiopharma.com)) in Golden, CO. Vitro Biopharma is a US Food and Drug Administration (FDA)-registered biomanufacturing firm whose cells have been FDA-authorized for use in human patients. They use the cyclic adenosine monophosphate technique. They also have international ISO 9001 and 13485 certifications. They have an active MSC Investigational New Drug with the FDA. Their cells and exosomes have been repeatedly approved for compassionate use for various patients in the United States.

### Dose Determination

The dose determination was extrapolated to human weight from murine model preclinical studies (16,17) showing efficacy. Additionally, in the process of performing 300 treatments in 130 unique patients in total in Antigua for various neurocognitive and neurodegenerative disorders, we have determined the appropriate

dose in the study of those patients with 1-6 months of follow-up based on our dose-escalation trials, as seen in Fig. 1 and Table 2. Repeat treatment was performed if a patient desired it after initial treatment at a minimum interval of 2 months between treatments.

### Instillation Protocol

Patients were instructed to take a single baby aspirin on the morning of treatment, unless they were on other anticoagulants or had a contraindication to baby aspirin. The administration route for treatment was intranasal instillation in each nostril. For treatment preparation, the frozen conditioned medium was thawed for 15 minutes in a 37°C water bath. A dose of exosome solution was instilled into each nostril. Patients were observed for 10 minutes and then discharged.

### Posttreatment Protocol

To assess the safety of the treatment, patients were observed for 30 minutes after treatment while monitoring vital signs. They were then observed on the evening of treatment, and again on the day after treatment. All patients were stable and without any adverse events at all observation points.

## RESULTS

Nineteen patients had a total of 40 treatments

Table 1. Patient demographics.

Characteristic	Value
No. of Patients	19
Age, y	
Mean	69
Median	73
Range	47-82
Gender	
Men	14/19 (73.68%)
Women	5/19 (26.32%)
Pretreatment PDQ-39 Score	
Mean	24.29
Median	22.08
Range	2.71-53.8
Tremor	
Yes	14/19 (73.68%)
No	5/19 (26.32%)

Abbreviations: y, year; PDQ-39, Parkinson's Disease Questionnaire.

throughout the trial. Two patients did not show any improvement, while all other patients (89.48%) reported some clinical improvements in one or more of the following categories: gait, tremor, speech, balance, muscle cramps, freezing of gait, cognition, brain fog, smell, and taste. However, 2 of these improvers had regression to baseline after one and 6 months and did not improve after a second treatment. One of the improvers was lost to follow-up after one month. The net result is that 15 of 19 patients had substantial improvement that was maintained at follow-up, ranging from 3 to 14 months.

### PDQ-39

PDQ-39 scores were obtained for all patients within one month prior to their first treatment and within one month after each treatment that followed. A decrease in the mean combined PDQ-39 score of all patients was observed after each additional treatment. Twelve patients (63.16%) demonstrated improved PDQ-39 scores, compared to their baseline score, after their

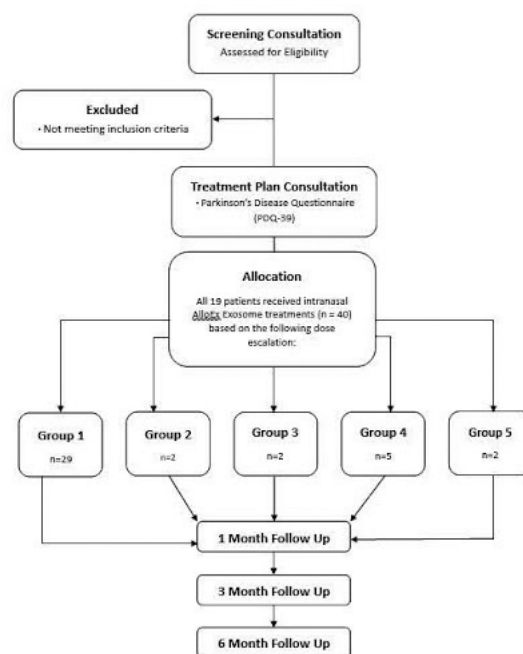


Fig. 1. CONSORT Flow Chart. Patients in Group 1 received a single dose of AlloEx Exosomes. Patients in Group 2 received a 1.25x single dose of AlloEx Exosomes. Patients in Group 3 received a 1.5x single dose of AlloEx Exosomes. Patients in Group 4 received a double dose of AlloEx Exosomes over the course of 2 consecutive days. Patients in Group 5 received a total dose of 2.5x AlloEx Exosomes over the course of 2 consecutive days.

first treatment. After the second treatment, 7 patients (38.88%) had improved PDQ-39 scores compared to their scores after the first treatment. Three of these patients (42.85%) demonstrated further improvement from the first treatment. After the third treatment, 2 patients (50%) had improved PDQ-39 scores compared to their scores after the second treatment. The calculated mean at each of these time points can be observed in Fig. 2. Overall, a total of 14 patients (73.68%) had an improved PDQ-39 score after their most recent treatment compared to their baseline score (Table 1).

**EEG Data**

EEG scans were performed before and after treatment for 7 of the enrolled patients. EEG data consisting of high beta and theta ratios across various brain regions were interpreted and reported by a neuropsychologist on our team. The average theta and high beta values before and after treatment are listed in Table 3. The EEG data collected for Patients 2, 3, 7, 9, and 14 showed significant improvement after receiving treatment. Patient 1 had normal EEG results at baseline, and posttreatment

Table 2. Patient-dosing regimen. Patients that received double-dose treatment over the course of 2 consecutive days are indicated by "x2."

Patient No.	Rx 1	Rx 2	Rx 3	Rx 4
1	May 2024	Jan 2025		
2	May 2024	Aug 2024	Jan 2025	
3	May 2024	Jan 2025		
4	Aug 2024	Jan 2025	Mar 2025 x2	
5	Aug 2024	Nov 2024		
6	Aug 2024	Nov 2024		
7	Aug 2024	Nov 2024	May 2025	
8	Aug 2024	Nov 2024	Mar 2025	
9	Nov 2024	Mar 2025		
10	Nov 2024	Jan 2025		
11	Jan 2025 x2	May 2025 x2		
12	Jan 2025	Mar 2025		
13	Jan 2025	Mar 2025 x2		
14	Jan 2025			
15	Jan 2025	Mar 2025 x2		
16	Jan 2025	May 2025 x2		
17	Mar 2025			
18	Mar 2025	May 2025 x2		
19	Mar 2025			

EEG data demonstrated a mild improvement in recovery after the treatment. Patient 8 had normal EEG results at baseline and had no further improvements after receiving treatment.

**Tremor**

Fourteen of the patients, who were enrolled in the trial, reported that they had a tremor before receiving treatment. Seven of these patients reported that the frequency and intensity of their tremors were diminished after receiving treatment, as seen in Figs. 3 and 4.

**Sensory Impairments**

Nine of the patients, who were enrolled in the trial, reported that they had a taste, smell, or combined taste and smell impairment before receiving treatment. Figures 5 and 6 demonstrate that a total of 4 unique patients reported significant sensorial improvements after receiving AlloEx Exosomes treatment.

**Bladder and Bowel Dysfunction**

Eleven of the patients enrolled indicated that they experienced some form of bladder or bowel dysfunction before receiving treatment. Four unique patients reported improvements in urinary frequency, constipation, or both, as seen in Figs. 7 and 8. One patient reported that his urinary frequency increased after treatment.

**Sleep**

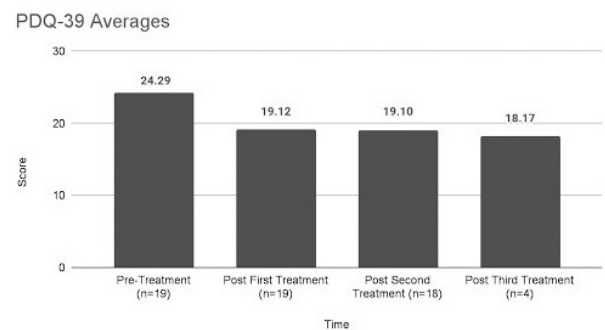


Fig. 2. PDQ-39 mean scores over time. PDQ-39, Parkinson's Disease Questionnaire

Table 3. Average theta and high beta.

Time	Average Theta	Average High Beta
Pretreatment	2.6089	0.5029
Posttreatment	2.5829	0.4471

Theta ideal range = 2.3-3.0. High Beta ideal range = 0.4-0.55.

Nine of the patients enrolled in the trial indicated that they experienced sleep issues before receiving AlloEx Exosome treatment. Four of these patients reported improved sleep quality after treatment, while one of these patients reported a further decrease in sleep quality, as seen in Fig. 9.

## DISCUSSION

This is the first report, of which we are aware, of a therapy that appears to be disease modifying for Parkinson's disease. Prior treatments for Parkinson's disease, such as carbidopa and levodopa, have only been shown to be symptom modifying, not disease modifying, and they do not appear to affect the long-term trajectory of

the demise of the patient. It is too soon to know with certainty if this exosome treatment is indeed disease modifying, but these early results indicate that it may well be.

The success rate of treatment was extraordinarily high, with 17 of the 19 patients showing some significant response and 14 of 19 showing enduring substantial benefit. Meaningful benefit was observed in results of the chief validated rating form for Parkinson's disease - the PDQ-39 form. Repeat treatment generally showed incremental improvement above the improvement from prior treatment, and, with a few exceptions, most patients showed little, if any, backsliding between treatments.

### Tremor Frequency

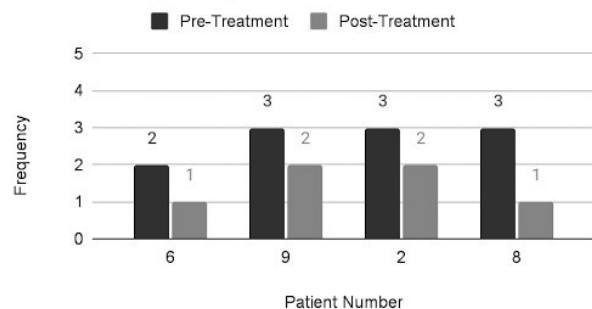


Fig. 3. Frequency of tremor before and after treatment of 4 initially affected patients. Tremor frequency was reported directly by the patient's response to the following Likert Scale: 1 = Never, 2 = Rarely, 3 = Every Few Days, 4 = Daily, 5 = Constant.

### Tremor Intensity

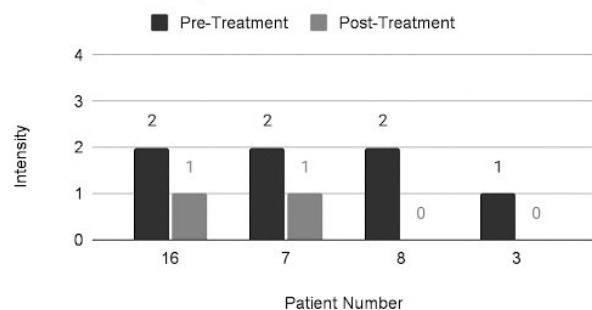


Fig. 4. Intensity of tremor before and after treatment of 4 initially affected patients. Tremor intensity was reported directly by the patient's response to the following Likert Scale: 1 = None, 2 = Mild, does not impede activities, 3 = Mild, impedes strenuous activities, 4 = Moderate, impedes activities of daily living, 5 = Strong, impedes activities of daily living.

### Taste Impairment

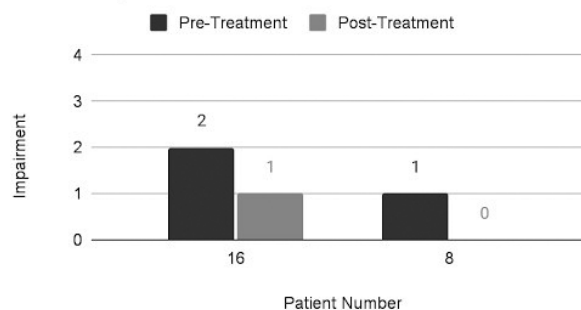


Fig. 5. Taste impairment before and after treatment of 2 initially affected patients. Taste impairment was reported directly by the patient's response to the following Likert Scale: 1 = Normal, 2 = Mildly impaired, 3 = Moderately impaired, 4 = Severely impaired, 5 = Absent.

### Smell Impairment

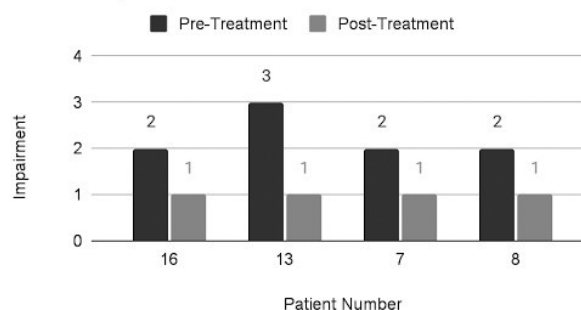


Fig. 6. Smell impairment before and after treatment of 4 initially affected patients. Smell impairment was reported directly by the patient's response to the following Likert Scale: 1 = Normal, 2 = Mildly impaired, 3 = Moderately impaired, 4 = Severely impaired, 5 = Absent.

Equally remarkable is the complete absence of any adverse events of any kind in any patient at any time during or after treatment. Patients left their treatment able to resume full activities without any restrictions. Indeed, almost half of patients reported better sleep and more energy after treatment. No patient reported any adverse event.

Restoration of taste and smell, in part or completely, was seen in almost all patients who experienced this common problem before treatment, and loss of restored taste and smell was not seen.

The frequency of treatment is not yet determined. All patients were enthusiastic over their improvement

### Urinary Frequency

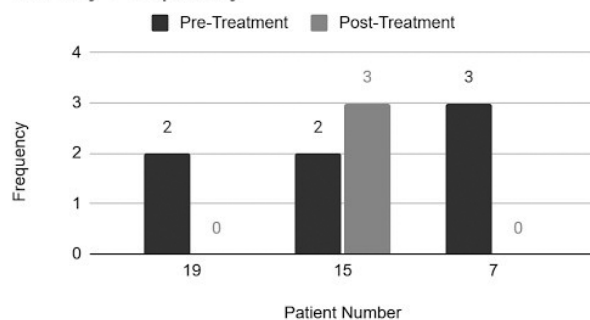


Fig. 7. Urinary frequency before and after treatment of 3 initially affected patients. Urinary frequency was reported directly by the patient's response to the following Likert Scale: 1 = Normal, 2 = Occasional, 3 = Constant, does not interfere with activities, 4 = Constant, interferes with activities, 5 = Must wear appliance.

### Constipation

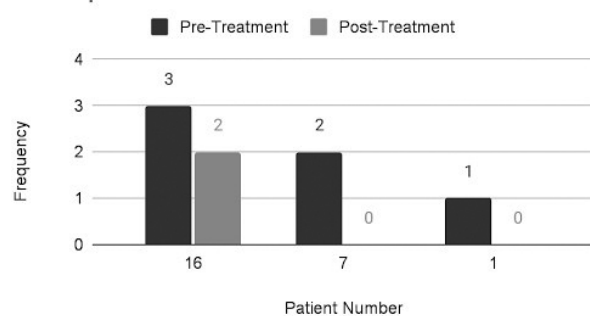


Fig. 8. Constipation frequency before and after treatment of 3 initially affected patients. Frequency of constipation was reported directly by the patient's response to the following Likert Scale: 1 = None, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Severe.

and universally were interested in repeat treatment, at intervals of no less than 2 months. When intervals were more prolonged, results were usually maintained. The longest interval was one of our index patients, treated in May 2024, whose second treatment was January 2025, at which time he had not shown deterioration. However, one patient had results only lasting one month, and another only 6 months. In general, second or third treatments showed incremental improvement compared to the first treatment, although this was not always true. Because most patients elected repeat treatment, it is difficult to determine how long the treatment would last if not repeated, but with one exception, the treatments always lasted for at least 2 months. Because the treatment has no side effects, a relatively frequent regimen is definitely feasible.

The rapidity of onset of benefit after treatment was stunning and unexpected. In most, but not all cases, patients had significant benefit within 6 hours of treatment. These effects, with the exceptions noted above, were generally maintained for many months.

Additionally, the presence of objective EEG data validates the clinical results reported by the patients. Specifically, patients overall showed transformational EEG changes that have never been reported from any medications after the exosome treatment.

Strengths of this study include a substantial number of patients: 19; with relatively long-term follow-up: up to 14 months posttreatment; and a high 95% follow-up rate overall. Another strength is the addition of measurements of tremor, taste and smell, urinary frequency, and constipation according to Likert scales, which we

### Sleep Quality

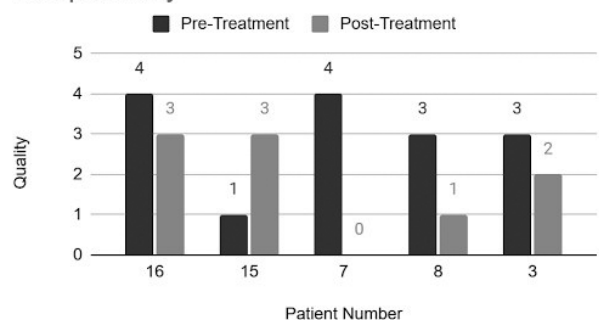


Fig. 9. Sleep quality before and after treatment of 5 initially affected patients. Sleep quality was reported directly by the patient's response to the following Likert Scale: 1 = Normal, 2 = Poor sleep, 3 = Wake up occasionally, 4 = Wake up nightly, 5 = Wake up multiple times per night.

devised for this paper. None of these important symptoms are addressed in the PDQ-39 scale, but significantly impact quality of life in these patients.

The study has no major weaknesses, but the obvious relative weakness is that the follow-up is still too short to validate whether the treatment is indeed disease modifying. We do not know if results will eventually attenuate in successfully treated patients, but the fact that at one-year follow-up this has not generally occurred is encouraging. Future reports should answer this question.

Intravenous infusion of stem cells has never been shown to be effective for Parkinson's disease. In our study, it is not clear if it is the use of exosomes instead of stem cells or the intranasal route rather than the intravenous route is the more important factor resulting in efficacy in our study not previously seen. It is also not clear if other qualified secretome/exosome treatments are as effective, or more effective, than the product used in this study.

Some studies (22) indicate that the mechanism of action of these exosomes may involve mitochondrial repair. While exosomes have anti-inflammatory properties, the fact that steroids do not directly improve Parkinson's would indicate the anti-inflammatory properties of exosomes are probably not the major factor resulting in the efficacy we have seen.

The finding that one patient had complete elimination of symptoms and was able to discontinue all Parkinson's disease-related medications is gratifying. We are hopeful that as the study continues, other patients may also achieve this goal, but we do not know how often this may be possible and how long this patient's

complete remission may be maintained, either with or without continued treatment.

## CONCLUSIONS

Nasal instillation of exosome-rich MSC secretome results in improved quality of life, a complete absence of side effects or adverse events, and a reduction in symptoms in most patients with Parkinson's disease.

## Declarations

### Ethics Approval and Consent to Participate

Name of the Institutional Approval Committee or Unit (IRB): The Foundation for Orthopedics and Regenerative Medicine IRB.

Date of Ethics Approval: May 2024. This study was conducted under appropriate ethical guidelines. It was reviewed and approved by the IRB board for the Foundation for Orthopedics and Regenerative Medicine. All patients signed an informed consent form stating that they were aware of the risks and benefits of the procedures and that they consented to take part in the research study.

### Human and Animal Rights

No animals were used for studies that are the basis of this research. All humans were used in accordance with the IRB board for the Foundation for Orthopedics and Regenerative Medicine and the Helsinki Declaration of 1975.

### Availability of Data and Methods

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

## REFERENCES

- Dexter DT, Jenner P. Parkinson disease: From pathology to molecular disease mechanisms. *Free Radic Biol Med* 2013; 62:132-144.
- Jankovic J. Parkinson's disease: Clinical features and diagnosis. *J Neurol Neurosurg Psychiatry* 2008; 79:368-376.
- Cattaneo C, Jost WH. Pain in Parkinson's disease: Pathophysiology, Classification and Treatment. *J Integr Neurosci* 2023; 22:132.
- Lew M. Overview of Parkinson's disease. *Pharmacotherapy* 2007; 27:155S-160S.
- Kempster PA, O'Sullivan SS, Holton JL, Revesz T, Lees AJ. Relationships between age and late progression of Parkinson's disease: A clinico-pathological study. *Brain* 2010; 133:1755-1762.
- Dickson DW, Braak H, Duda JE, et al. Neuropathological assessment of Parkinson's disease: Refining the diagnostic criteria. *Lancet Neurol* 2009; 8:1150-1157. Erratum in: *Lancet Neurol* 2010; 9:140. Erratum in: *Lancet Neurol* 2010; 9:29.
- Calabresi P, Mechelli A, Natale G, Volpicelli-Daley L, Di Lazzaro G, Ghiglieri V. Alpha-Synuclein in Parkinson's disease and other synucleinopathies: From overt neurodegeneration back to early synaptic dysfunction. *Cell Death Dis* 2023; 14:176.
- Recchia A, Debetto P, Negro A, Guidolin D, Skaper SD, Giusti P. Alpha-Synuclein and Parkinson's disease. *FASEB J* 2004; 18:617-626.
- Tanner CM. Advances in environmental epidemiology. *Mov Disord* 2010; 25(suppl 1):S58-S62.
- Lim SY. Genetics in Parkinson's disease – coming to the fore of day-to-day clinical and research practice. *Neurotorium* 2025. <https://neurotorium.org/genetics-parkinsons-clinical-research/>
- Zahoor I, Shafi A, Haq E. Pharmacological treatment of Parkinson's disease. In: Stoker TB, Greenland JC (eds). *Parkinson's Disease: Pathogenesis and Clinical Aspects [Internet]*. Codon Publications, Brisbane, AU 2018.
- Hayes MT. Parkinson's disease and Parkinsonism. *Am J Med* 2019; 132:802-807.
- Gandhi KR, Saadabadi A. Levodopa (L-Dopa). In: *StatPearls [Internet]*. StatPearls Publishing, Treasure Island, FL 2026. [www.ncbi.nlm.nih.gov/books/NBK482140/](http://www.ncbi.nlm.nih.gov/books/NBK482140/)
- Tambasco N, Romoli M, Calabresi P. Levodopa in Parkinson's disease: Current status and future developments. *Curr Neuropharmacol* 2018; 16:1239-1252.
- Leyden E, Tadi P. Carbidopa. In: *StatPearls [Internet]*. StatPearls Publishing, Treasure Island, FL 2025. [www.ncbi.nlm.nih.gov/books/NBK554552/](http://www.ncbi.nlm.nih.gov/books/NBK554552/)
- Fahn S. Levodopa in the treatment of Parkinson's disease. *J Neural Transm Suppl* 2006; 71:1-15.
- Riederer P, Strobel S, Nagatsu T, et al. Levodopa treatment: Impacts and mechanisms throughout Parkinson's disease progression. *J Neural Transm (Vienna)* 2025; 132:743-779.
- Pandey S, Srivanitchapoom P. Levodopa-Induced dyskinesia: Clinical features, pathophysiology, and medical management. *Ann Indian Acad Neurol* 2017; 20:190-198.
- Chen HX, Liang FC, Gu P, et al. Exosomes derived from mesenchymal stem cells repair a Parkinson's disease model by inducing autophagy. *Cell Death Dis* 2020; 11:288.
- Osaid Z, Haider M, Hamoudi R, Harati R. Exosomes interactions with the blood-brain barrier: Implications for cerebral disorders and therapeutics. *Int J Mol Sci* 2023; 24:15635.
- Williams A, Branscome H, Kashanchi F, Batrakova EV. Targeting of extracellular vesicle-based therapeutics to the brain. *Cells* 2025; 14:548.
- Si Q, Wu L, Pang D, Jiang P. Exosomes in brain diseases: Pathogenesis and therapeutic targets. *MedComm (2020)* 2023; 4:e287.
- Li Y, Li Z, Gu J, Xu X, Chen H, Gui Y. Exosomes isolated during dopaminergic neuron differentiation suppressed neuronal inflammation in a rodent model of Parkinson's disease. *Neurosci Lett* 2022; 771:136414.
- Yao Y, Huang C, Gu P, Wen T. Combined MSC-secreted factors and neural stem cell transplantation promote functional recovery of PD rats. *Cell Transplant* 2016; 25:1101-1113.
- Bonafede R, Turano E, Scambi I, et al. ASC-Exosomes ameliorate the disease progression in SOD1(G93A) murine model underlining their potential therapeutic use in human ALS. *Int J Mol Sci* 2020; 21:3651.
- Zhou J, Li F, Jia B, et al. Intranasal delivery of small extracellular vesicles reduces the progress of amyotrophic lateral sclerosis and the overactivation of complement-coagulation cascade and NF- $\kappa$ B signaling in SOD1<sup>G93A</sup> mice. *J Nanobiotechnol* 2024; 22:503.
- Wu S, Yang T, Ma M, et al. Extracellular vesicles meet mitochondria: Potential roles in regenerative medicine. *Pharmacol Res* 2024; 206:107307.
- Armstrong MJ, Okun MS. Diagnosis and treatment of Parkinson disease: A review. *JAMA* 2020; 323:548-560.