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Fish Oil's Effect on Depression and Dyskinesia in Parkinson's Disease

Colin O'Keefe and Jocely Cattley
Mount Saint Mary College, Newburgh, New York

Parkinson's disease is currently the second most common neurodegenerative disorder found in the aging population (de Lau & Breteler, 2006). This population develops not only motor symptoms, but also depression, affecting about 40 percent of those diagnosed (Brown & Jahanshahi, 1994). The intake of omega-3 can be used for an antidepressant effect or to complement other medication (da Silva et al., 2008). The current treatment options for the motor symptoms of Parkinson's disease are limited, yet the most popular treatment is levodopa (L-Dopa), a dopamine regenerative medication. While levodopa treatment is initially effective, symptoms will worsen over time and stop responding to the levodopa (Fahn, 2003). Levodopa treatment has severe side effects, such as the development of dyskinesia, which are involuntary movements (Samedi et al., 2006). Current research suggests that one method of counteracting the severe symptoms of L-Dopa could be the daily consumption of fish oils, or Omega-3 fatty acids (Patrick, 2013). It is hypothesized that a daily dose of fish oil pills given to Parkinson's patients, in accordance with levodopa treatment, will reduce the patient's dyskinesia and depression.

Pages: 10-16

Parkinson's disease is the second most common neurodegenerative disorder and continues to affect the aging population and society both socially and economically (de Lau & Breteler, 2006). According to the Parkinson's Disease Foundation (2015), Parkinson's disease affects up to four percent of those over the age of 60. About 90 percent of these instances are random and cannot be predicted by genes or family history (de Lau & Breteler, 2006). According to Van Den Eeden et al. (2003), 60 percent of the time, onset age is between 65 and 79 years old. Life expectancy from the time of diagnosis is about 15-20 years (Elbaz et al., 2003). Parkinson's disease has a serious affect on society, which makes this a vital topic of research.

Colin O'Keefe (*coke0664@my.msmc.edu*) is a student at Mount Saint Mary College majoring in Psychology pursuing a Doctorate in Physical Therapy.
Jocelyn Cattley (*jcat2903@my.msmc.edu*) is a student at Mount Saint Mary College majoring in Psychology looking to pursue a career in hospitality and marketing.

With the high prevalence of Parkinson's disease, understanding this disorder is crucial for the care of patients. Parkinsonism is a clinical syndrome made up of combinations of different motor problems (Fahn, 2003). There are six cardinal symptoms of Parkinsonism: resting tremor, bradykinesia (slowed movements), rigidity (increased muscular tone), loss of postural reflexes, flexed posture of neck, trunk, and limbs, and gait impairment (Fahn, 2003). In order for a Parkinson's diagnosis, at least two of these symptoms must be present, with one being either resting tremor or bradykinesia (Fahn, 2003). Parkinson's disease is the category of Parkinsonism that our study will be focusing on. Three symptoms of Parkinson's disease are: an asymmetrical onset of motor symptoms, the presence of rest tremor, and positive response to levodopa therapy (Fahn, 2003). It has been shown that these symptoms of Parkinson's disease are associated with the loss of striatal dopamine and the impairment of striatal dopamine receptors

(Fahn, 2003). However, improvement of the mental symptoms of Parkinson's disease is just as important as treating the physical symptoms that come along with the disease.

Another symptom of Parkinson's disease is the development of depression. Depression affects about 40 percent of those with Parkinson's (Brown & Jahanshahi, 1994). This has been associated with a loss of dopamine and noradrenaline innervation of cortical and subcortical components of the limbic system (Remy, Doder, Lees, Turjanski, & Brooks, 2005). It is important to address these symptoms with the same concern as the motor symptoms: resting tremor, bradykinesia, etc. According to the National Health Committee (1996), it is estimated that 20-30 percent of those with major depressive disorder who are treated with antidepressant medication continue to experience depressive symptoms. The research also shows that up to 50 percent of people who have experienced major depressive disorder will eventually have another episode (National Health Committee, 1996). As we have seen, depression is widespread among the elderly community and specifically those who have Parkinson's disease. Finding a safe treatment is vital for the overall livelihood of Parkinson's patients.

Along with depression, motor symptoms arise in Parkinson's disease. Treatment for the motor symptoms of Parkinson's disease is being addressed by the use of Levodopa (Arminoff, 1994). Levodopa (L-dopa) is a precursor to dopamine, an important motor neurotransmitter, used to treat symptoms that first show in Parkinson's such as rest tremors and bradykinesia (Fahn, 2003). Rather than just the conversion of levodopa to dopamine, the drug also has direct beneficial neuro-modulatory and neurotransmitter effects (Misu, Kitahama, Goshima, 2002). This drug is a short term treatment as it only take 15 to 20 minutes for an oral levodopa pill to help a patient temporarily recovery from their current impairments in speech, dexterity, and gait (LeWitt, 2008). Once levodopa is taken orally, it is actively transported from the upper small intestine into the bloodstream by a mechanism that is specific for large, neutral l-amino acids (LeWitt, 2008). This is an effective treatment option, but due to the widespread use of levodopa throughout the body, only a small portion of the levodopa will actually pass throughout the blood brain barrier and be able to replace the loss of dopamine from Parkinson's disease (Nutt & Fellman, 1984). Furthermore, this treatment, while effective initially, is less effective over time and the body will stop responding to L-dopa (Fahn, 2003). Eventually, levodopa treatment itself will result in side effects like dyskinesia, which are involuntary movements (Samedi et al., 2006). Dyskinesia is caused by the immense influx of dopamine from levodopa treatment (Cenci, 2007). Research by the Parkinson Study Group (2000) found that 32 percent of subjects with Parkinson's disease had dyskinesia. Those who have been diagnosed with Parkinson's disease have already lost about 80 percent of their dopaminergic neurons, which produce dopamine (Sulzer, 2007). To go from these low levels of dopamine, because of the loss of dopaminergic neurons, to very high levels of dopamine produced from levodopa, stresses the nigrostriatal dopaminergic system (Cenci, 2007). When this stress arises, presynaptic dopamine is disrupted causing a cascade effect (Cenci, 2007). Postsynaptic neurons are then disrupted, complicating motor function (Cenci, 2007). This requires the use of another drug or a supplemental drug that can allow levodopa to maximize its healing potential.

Additionally, fish oils have been proposed as a supplemental drug to alleviate some of the side effects of levodopa treatment. This is because levodopa-induced dyskinesia may be caused by a loss of docosahexaenoic acid (DHA), although this exact mechanism is not totally understood (Patrick, 2013). Studies have shown that intake of omega-3 in a non-human primate model for Parkinson's disease reduced the frequency of dyskinesia induced by levodopa (Carl, et.al, 2006). This reduction of the frequency of dyskinesia has been estimated to be by about 40 percent in primates (Samedi et al., 2006). Patrick (2013) suggests that a dietary supplementation of DHA can reduce or even eliminate this dyskinesia in humans. DHA is a major part of long chain omega 3 fatty acids that are found in fish and fish oil pills (Allen & Bartlett, 2002). Fish oil pills consist of omega 3 fatty acids, which are essential fatty acids, meaning that they cannot be produced in the body and must be taken in through diet (Berquin, Edwards, & Chen, 2008). DHA has been found to promote neurotransmission by increasing the number of certain synapses, including those associated with dopamine (Wurtman, 2008). From this research, the supplementation of oral DHA will be able to help offset the loss of dopaminergic neurons in the striatum.

Interestingly, fish oils have also been proposed to prevent Parkinson's disease. Ideally, we should consume a ratio of omega-6 to omega-3 fatty acids that is 1:1. However, in America we stand at an average ratio of about 20:1 (Simopoulos, 2002). A follow-up study based on food questionnaires, revealed that Mediterranean diets, traditionally composed of vegetables, fruits and fish, are associated with a reduced incidence of Parkinson's

disease (Gao et al., 2007). In another study, over 5,000 subjects were evaluated for the risk of developing Parkinson's in relation to dietary intake of fatty acids. After a 6-year follow-up, it was observed that high consumption of omega-3 fatty acids was associated with a decreased risk of this disease (de Lau et al., 2005). These studies show that a diet high in omega-3 fatty acids can limit the incidence of Parkinson's disease. However, studies have shown the daily consumption of fish oil pills could also limit levodopa induced dyskinesia and depressive symptoms of Parkinson's disease (Patrick, 2013; Tajalizadekhoob et al., 2010). These effects are presumably due to the DHA in fish oils.

Furthermore, depression, which is also associated with Parkinson's disease, may benefit from intake of omega-3 fatty acids. Parkinson's disease causes the loss of dopaminergic neurons, which leads to a great decrease in the output of dopamine in the brain (Lang & Lozano, 1998). However, research has shown that dietary intake of omega-3 fatty acids can increase dopamine levels in the frontal cortex by 40 percent (Das & Fams, 2003). Tajalizadekhoob et al. (2010) concluded that low doses of omega-3 fatty acids were effective in treatment of mild to moderate depression in an elderly population. Tajalizadekhoob's research shows that omega-3 fatty acids have been effective in decreasing depressive symptoms. Another study found that Parkinson's patients taking fish oil, with or without antidepressants, showed improvement in depressive symptoms (da Silva et al., 2008). The intake of omega-3 could be used for an antidepressant effect or coupled with other medications as a treatment for Parkinson's patients. It is hypothesized that a daily dose of fish oil pills given to Parkinson's patients, in accordance with levodopa treatment, will reduce the participants' dyskinesia and depression.

PROPOSED METHOD

Study Design

We will conduct an experimental study, which will evaluate the use of fish oil pills as supplemental medication to Parkinson's patients currently on levodopa treatment. This will allow us to see the effects fish oil pills have on both Parkinson's symptoms and the side effects of levodopa treatment, namely dyskinesia.

Participants

Our participants will be recruited through convenience sampling, selecting 2,000 males who have already been diagnosed with Parkinson's disease. Their local physicians, who will also be responsible for yearly checkups, will refer the participants to the study. These participants will be between the ages of 65 and 70 years old, currently receiving levodopa treatment, are not currently taking fish oil pills, and are currently residing in an assisted living home. This is to control many variables along with keeping the participants in a relatively similar setting, even if it is seen across the country. There will not be any restrictions based on race. All participants will be given $1,000 a year for their participation in the study. Informed consent will be required by all participants, gathered by the healthcare providers at the pre-screened assisted living facilities, before their participation in the experiment and will be gathered nation-wide.

Materials

Our study will require the use of many materials, mainly fish oil pills. We will be providing these pills to the participants at no cost, in addition to paying them $1,000 a year to participate in the study. The pills will be Spring Valley, 600mg tablets. Scales will also be required to measure both the movement and depression in patients. Movement measurement will be taken using the Rush Dyskinesia Rating Scale (Goetz et al., 1994). Depression will be measured using the BECK Depression Inventory (Beck, Epstein, Brown, & Steer, 1988).

Procedure

Two thousand participants will be recruited using convenience sampling and will be given $1,000 a year to participate in the study. Participants will be selected based on previously stated factors and will be required to give informed consent. Participants will take baseline tests in both the Rush Dyskinesia Rating Scale and BECK Depression Inventory, both supervised by a certified physician. This is in order to establish what their scores are before the intervention is made. The 2,000 males will be randomly assigned to one of two groups, the experimental, which will take a fish pill daily, and the control group, which will receive no pill in addition to their levodopa treatment. Every year, all 2,000 participants will return to their same physician to retake both tests to see if there is improvement. Since the average time from diagnosis to death is 15 to 20 years, the study will continue until death so that any effect on longevity can be observed. After death, an autopsy will be performed and the results will be recorded to see if there is a difference in brain structures, specifically

the dopaminergic neurons, between either of the groups.

CONCLUDING REMARKS

Significance

This study is imperative to the advancement of treatment for Parkinson's disease patients. Parkinson's disease is a terrible reality because of the way it breaks a person down, both mentally and physically. This disease leaves people feeling not only depressed, but also unable to completely care for them self. With an aging population, we will only see more and more people experiencing Parkinson's disease. Levodopa treatment is very effective for Parkinson's patients for a limited period of time, but the down side is that the benefits only last for so long before symptoms return and the patient has lost total control over their body. Not only is fish oil treatment an effective supplemental drug, it is also very safe for the overall well being of the patients undergoing current levodopa treatment. For example, each container of fish oil pills comes with 75 tablets and it is projected that each pill will cost 4 cents at most (Amazon.com, Inc., 2015). This study will research the supplementation of fish oil pills with levodopa treatment for Parkinson's patients over a significant period of time. The longitudinal nature of the study will allow the side effects of levodopa treatment to be treated and to diminish over the course of a person's life, allowing them to live more comfortably. Advancements in fish oil research may provide an inexpensive option to reduce depression and dyskinesia in this population and allow them to live a more controlled and fulfilling life.

Limitations

The limitations within the study are limited to preliminary observations. Once the study is actually executed, this will result in the discovery of more limitations. This study will only be evaluating the effects of fish oil on male participants, thus completely excluding the entire female population. While excluding females may be a limitation, it is a necessary control since only including males better allows us to observe the direct effects of fish oil pills without extraneous variables. Another limitation is that our participants are between the ages of 65-70 therefore the manifestation of Parkinsonism symptoms such as tremors will not be as severe as compared to those diagnosed at a lager age. Also, most patients will not have been on levodopa treatment for very long since the earliest age of diagnosis is generally 65. This also excludes a vast amount of the population that has Parkinson's disease and narrows down the age range significantly. Therefore, any results that we obtain may not be applicable to patients who are over 70 years of age with advanced form of Parkinson's disease. Another limitation would be the varying level of care that the patient may receive at an assisted living home. According to a study done in the UK, data was found to support there being a severe lack of care for the patients in nursing homes, such as the lack of immunizations, medications, and physical therapy (Fahey, Montgomery, Barnes, & Protheroe, 2003). We believe these results are transferable to the US and indicate that this lack of care may affect the results of the study due to its impact on each patient's health.

REFERENCES

Allen, E. E., & Bartlett, D. H. (2002). Structure and regulation of the omega-3 polyunsaturated fatty acid synthase genes from the deep-sea bacterium Photobacterium profundum strain SS9. *Microbiology, 148*(6), 1903-1913.

Amazon.com, Inc. (2015). Spring Valley all natural fish oil 600 mg, 300 mg omega-3, twin pack, 2 x 75 mini softgels. Retrieved April 27, 2015, from http://www.amazon.com/Spring-Valley-Natural-Omega-3-Softgels/dp/B00O1F582U

Aminoff, M. J. (1994). Treatment of Parkinson's disease. *Western Journal of Medicine*, *161*(3), 303.

Beck, A. T., Epstein, N., Brown, G., & Steer, R. A. (1988). An inventory for measuring clinical anxiety: Psychometric properties. *Journal of Consulting and Clinical Psychology, 56*(6), 893.

Berquin, Isabelle M., Edwards, J. I., Chen, G. Y. (2008). "Multiple targeted therapy kf cancer by omega-3 fatty acids". *Cancer Letters 269*(2): 363-377.

Bousquet, M., Calon, F., & Cicchetti, F. (2011). Impact of omega-3 fatty acids in Parkinson's disease. *Aging Research Reviews, 10*(4), 453-463.

Brown, R., & Jahanshahi, M. (1994). Depression in Parkinson's disease: A psychosocial viewpoint. *Advances in Neurology, 65*, 61-84.

Cenci, M. A. (2007). Dopamine dysregulation of movement control in L-DOPA-induced dyskinesia. *Trends in Neurosciences, 30*(5), 236-243.

da Silva, T. M., Munhoz, R. P., Alvarez, C., Naliwaiko, K., Kiss, Á., Andreatini, R., & Ferraz, A. C. (2008). Depression in Parkinson's disease: A double-blind, randomized, placebo-controlled pilot study of omega-3 fatty-acid supplementation. *Journal of Affective Disorders, 111*(2), 351-359.

Das, U. N. (2003). Long-chain polyunsaturated fatty acids in the growth and development of the brain and memory. *Nutrition*, *19*(1), 62-65.

de Lau, L. M., Bornebroek, M., Witteman, J. C., Hofman, A., Koudstaal, P. J., & Breteler, M. M. (2005). Dietary fatty acids and the risk of Parkinson disease: The Rotterdam study. *Neurology*, *64*(12), 2040-2045.

de Lau, L. M., & Breteler, M. M. (2006). Epidemiology of Parkinson's disease. *The Lancet Neurology, 5*(6), 525-535.

Elbaz, A., Bower, J. H., Peterson, B. J., Maraganore, D. M., McDonnell, S. K., Ahlskog, J. E., ... & Rocca, W. A. (2003). Survival study of Parkinson disease in Olmsted

County, Minnesota. *Archives of Neurology, 60*(1), 91-96.
Fahey, T., Montgomery, A. A., Barnes, J., & Protheroe, J. (2003). Quality of care for elderly residents in nursing homes and elderly people living at home: Controlled observational study. *BMJ, 326*(7389), 580.
Fahn, S. (2003). Description of Parkinson's disease as a clinical syndrome. *Annals of the New York Academy of Sciences, 991*(1), 1-14.
Gao, X., Chen, H., Fung, T. T., Logroscino, G., Schwarzschild, M. A., Hu, F. B., & Ascherio, A. (2007). Prospective study of dietary pattern and risk of Parkinson disease. *The American Journal of Clinical Nutrition, 86*(5), 1486-1494.
Goetz, C. G., Stebbins, G. T., Shale, H. M., Lang, A. E., Chernik, D. A., Chmura, T. A., ... & Dorflinger, E. E. (1994). Utility of an objective dyskinesia rating scale for Parkinson's disease: Inter-and intrarater reliability assessment. *Movement Disorders, 9*(4), 390-394.
Hibbeln, J. R. (1998). Fish consumption and major depression. *The Lancet, 351*(9110), 1213-1214
Lang, A. E., & Lozano, A. M. (1998). Parkinson's disease. *New England Journal of Medicine, 339*(15), 1044-1053.
LeWitt, P. A. (2008). Levodopa for the treatment of Parkinson's disease. *New England Journal of Medicine*, *359*(23), 2468-2476.
Li, F., Harmer, P., Fitzgerald, K., Eckstrom, E., Stock, R., Galver, J., ... & Batya, S. S. (2012). Tai Chi and postural stability in patients with Parkinson's disease. *New England Journal of Medicine, 366*(6), 511-519.
National Health Committee. (1996). *Guidelines for the treatment and management of depression by primary healthcare professionals*. New Zeland: Wellington Press.
Parkinson Study Group. (2000). Pramipexole vs levodopa as initial treatment for Parkinson disease: A randomized controlled trial. *Jama, 284*(15), 1931-1938.
Parkinson's Disease Foundation. (2015). Causes. Retrieved from http://www.pdf.org/en/causes?gclid=COzGpYCEnMQCFRc8gQodg70AZQ
Patrick, R. P. (2013). The importance of omega-3.
Remy, P., Doder, M., Lees, A., Turjanski, N., & Brooks, D. (2005). Depression in Parkinson's disease: Loss of dopamine and noradrenaline innervation in the limbic system. *Brain, 128*(6), 1314-1322.
Samadi, P., Grégoire, L., Rouillard, C., Bédard, P. J., Di Paolo, T., & Lévesque, D. (2006). Docosahexaenoic acid reduces levodopa-induced dyskinesias in 1-methyl-4-phenyl-1, 2, 3, 6-tetrahydropyridine monkeys. *Annals of Neurology,59*(2), 282-288.
Shulman, J. M., De Jager, P. L., & Feany, M. B. (2011). Parkinson's disease: Genetics and pathogenesis. *Annual Review of Pathology: Mechanisms of Disease,* (6), 193-222.
Simopoulos, A. P. (2002). The importance of the ratio of omega-6/omega-3 essential fatty acids. *Biomedicine & Pharmacotherapy*, *56*(8), 365-379.
Sulzer, D. (2007). Multiple hit hypotheses for dopamine neuron loss in Parkinson's disease. *Trends in Neurosciences, 30*(5), 244-250.
Tajalizadekhoob, Y., Sharifi, F., Fakhrzadeh, H., Mirarefin, M., Ghaderpanahi, M., Badamchizade, Z., & Azimipour, S. (2011). The effect of low-dose omega 3 fatty acids on the treatment of mild to moderate depression in the elderly: A double-blind, randomized, placebo-controlled study. *European Archives of Psychiatry and Clinical Neuroscience, 261*(8), 539-549.
Van Den Eeden, S. K., Tanner, C. M., Bernstein, A. L., Fross, R. D., Leimpeter, A., Bloch, D. A., & Nelson, L. M. (2003). Incidence of Parkinson's disease: Variation by age, gender, and race/ethnicity. *American Journal of Epidemiology,157*(11), 1015-1022.
Wurtman, R. J. (2008). Synapse formation and cognitive brain development: Effect of docosahexaenoic acid and other dietary constituents. *Metabolism, 57*, S6-10.

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Appendix A

Rush Dyskinesia Scale

TABLE 1. *Dyskinesia rating scale*

Directions:
1. View the patient walk, drink from a cup, put on a coat button clothing.
2. Rate the severity of dyskinesias. These may include rea, dystonia, and other dyskinetic movements in combinat Rate the patient's worst function.
3. Check which dyskinesias you see (more than one resp possible).
4. Check the type of dyskinesia that is causing the most ability on the tasks seen on the tape (only one response is mitted).

Severity rating code: 0, absent; 1, minimal severity, no i ference with voluntary motor acts; 2, dyskinesias may im voluntary movements but patient is normally capable of un taking most motor acts; 3, intense interference with mover control and daily life activities are greatly limited; 4, vic dyskinesias, incompatible with any normal motor task.

Severity of worst dyskinesia observed	Dyskinesias present (more than one choice possible)			Most disabl dyskinesi (choose on		
	Chorea (C)	Dystonia (D)	Other (list)	C	D	O

Appendix B

Beck's Depression Inventory

Roche | **Beck Depression Inventory** | **Baseline**

V 0477 | CRTN: _____ CRF number: _____ | Page 14 | patient inits: _____

BDI-II | Date:

Name: _____ Marital Status: _____ Age: _____ Sex: _____

Occupation: _____ Education: _____

Instructions: This questionnaire consists of 21 groups of statements. Please read each group of statements carefully, and then pick out the **one statement** in each group that best describes the way you have been feeling during the **past two weeks, including today**. Circle the number beside the statement you have picked. If several statements in the group seem to apply equally well, circle the highest number for that group. Be sure that you do not choose more than one statement for any group, including Item 16 (Changes in Sleeping Pattern) or Item 18 (Changes in Appetite).

1. Sadness
- 0 I do not feel sad.
- 1 I feel sad much of the time.
- 2 I am sad all the time.
- 3 I am so sad or unhappy that I can't stand it.

2. Pessimism
- 0 I am not discouraged about my future.
- 1 I feel more discouraged about my future than I used to be.
- 2 I do not expect things to work out for me.
- 3 I feel my future is hopeless and will only get worse.

3. Past Failure
- 0 I do not feel like a failure.
- 1 I have failed more than I should have.
- 2 As I look back, I see a lot of failures.
- 3 I feel I am a total failure as a person.

4. Loss of Pleasure
- 0 I get as much pleasure as I ever did from the things I enjoy.
- 1 I don't enjoy things as much as I used to.
- 2 I get very little pleasure from the things I used to enjoy.
- 3 I can't get any pleasure from the things I used to enjoy.

5. Guilty Feelings
- 0 I don't feel particularly guilty.
- 1 I feel guilty over many things I have done or should have done.
- 2 I feel quite guilty most of the time.
- 3 I feel guilty all of the time.

6. Punishment Feelings
- 0 I don't feel I am being punished.
- 1 I feel I may be punished.
- 2 I expect to be punished.
- 3 I feel I am being punished.

7. Self-Dislike
- 0 I feel the same about myself as ever.
- 1 I have lost confidence in myself.
- 2 I am disappointed in myself.
- 3 I dislike myself.

8. Self-Criticalness
- 0 I don't criticize or blame myself more than usual.
- 1 I am more critical of myself than I used to be.
- 2 I criticize myself for all of my faults.
- 3 I blame myself for everything bad that happens.

9. Suicidal Thoughts or Wishes
- 0 I don't have any thoughts of killing myself.
- 1 I have thoughts of killing myself, but I would not carry them out.
- 2 I would like to kill myself.
- 3 I would kill myself if I had the chance.

10. Crying
- 0 I don't cry anymore than I used to.
- 1 I cry more than I used to.
- 2 I cry over every little thing.
- 3 I feel like crying, but I can't.

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Subtotal Page 1

Continued on Back

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