Description

Title of Invention: AGENT FOR PREVENTING OR TREATING SPINOCEREBELLAR ATAXIA

Technical Field

[0001]

The present invention relates to an agent for preventing or treating spinocerebellar ataxia, comprising 1-(3-(2-(1-benzothiophen-5-yl)ethoxy)propyl)azetidin-3-ol or a salt thereof as an active ingredient.

Background Art

[0002]

Spinocerebellar ataxia is a neurodegenerative disease whose main symptoms are cerebellar or posterior column ataxia and spastic paraplegia. Spinocerebellar ataxia can be roughly divided into two types: hereditary spinocerebellar ataxia and non-hereditary spinocerebellar ataxia. Examples of hereditary spinocerebellar ataxia include hereditary olivopontocerebellar atrophy, hereditary cortical cerebellar atrophy, spinocerebellar ataxia type 1, spinocerebellar ataxia type 2, spinocerebellar ataxia type 3 (Machado-Joseph disease), spinocerebellar ataxia type 6, spinocerebellar ataxia type 31, hereditary dentatorubropallidoluysian atrophy, ataxia telangiectasia, Friedreich's ataxia, ataxia with vitamin E deficiency, aprataxin deficiency, senataxin deficiency, spastic ataxia of Charlevoix-Saguenay and hereditary spastic paraplegia. Examples of non-hereditary spinocerebellar ataxia include olivopontocerebellar atrophy, Shy-Drager syndrome, striatonigral degeneration and cortical cerebellar atrophy. While spinocerebellar ataxia with an initial symptom of cerebellar ataxia has been called olivopontocerebellar atrophy, one with an initial symptom of parkinsonism has been called striatonigral degeneration, and one with significant autonomic neuropathy such as orthostatic hypotension has been called Shy-Drager syndrome, from the fact that in all cases symptoms overlap as the disease progresses, brainstem and cerebellar

atrophy and striatal abnormalities are found and there are common histopathological findings, these diseases may be collectively called multiple system atrophy.

For drug therapy, thyrotropin-releasing hormone (TRH) or TRH derivatives are used for all ataxia symptoms. Drugs symptomatically used for each disease include mexiletine hydrochloride for painful muscle cramps and acetazolamide for episodic dystonia and symptoms of dizziness.

[0003]

1-(3-(2-(1-benzothiophen-5-yl)ethoxy)propyl)azetidin-3-ol (hereinafter referred to as "Compound A") or a salt thereof is known to have neuroprotective, nerve regeneration-promoting and neurite outgrowth actions, and be useful as a therapeutic agent for central and peripheral neurological diseases (Patent Literature 1). Furthermore, a publication discloses that usually the drug may be administered to an adult in a dose or divided doses of 0.01 to 500 mg per day (Patent Literature 2).

Prior Art Literatures

Patent Literature

[0004]

Patent Literature 1: International Publication No. WO 2003/035647

Patent Literature 2: International Publication No. WO 2003/105830

Summary of Invention

Problem to be Solved by the Invention

[0005]

An object of the present invention is to provide an excellent drug for preventing or treating spinocerebellar ataxia.

Means for Solving Problem

[0006]

In such circumstances, the present inventors have found that Compound A or a salt thereof has an effect of suppressing cerebellar atrophy and have completed the present invention.

[0007]

The present invention provides the following.

(1) An agent for preventing or treating spinocerebellar ataxia, comprising Compound A or a salt thereof as an active ingredient.

(2) The agent for preventing or treating spinocerebellar ataxia according to (1), wherein the spinocerebellar ataxia is hereditary olivopontocerebellar atrophy, hereditary cortical cerebellar atrophy, spinocerebellar ataxia type 3 (Machado-Joseph disease), spinocerebellar ataxia type 6, spinocerebellar ataxia type 31 or cortical cerebellar atrophy.

(3) The agent for preventing or treating spinocerebellar ataxia according to (1) or (2), wherein the agent is for suppressing cerebellar atrophy in a patient with spinocerebellar ataxia.

(4) The agent for preventing or treating spinocerebellar ataxia according to (1) or (2), wherein the agent is for improving ataxia in a patient with spinocerebellar ataxia.

(5) The agent for preventing or treating spinocerebellar ataxia according to (1) or (2), wherein the agent is for improving balance disorder in a patient with spinocerebellar ataxia.

(6) The agent for preventing or treating spinocerebellar ataxia according to any one of (1) to (5), wherein the agent is orally administered in a dose of 100 mg to 400 mg in terms of Compound A once a day.

(7) The agent for preventing or treating spinocerebellar ataxia according to any one of (1) to (5), wherein the agent is orally administered in a dose of 160 mg or 320 mg in terms of Compound A once a day.

[0008]

The present invention also provides the following.

(a) A pharmaceutical composition for preventing or treating spinocerebellar ataxia, comprising Compound A or a salt thereof as an active ingredient.

(b) Compound A or a salt thereof for use in prevention or treatment of spinocerebellar ataxia.

(c) A method of preventing or treating spinocerebellar ataxia, comprising administering Compound A or a salt thereof to a patient.

(d) Use of Compound A or a salt thereof for producing an agent for preventing or treating spinocerebellar ataxia.

(e) An agent for suppressing cerebellar atrophy, comprising Compound A or a salt thereof as an active ingredient.

(f) Compound A or a salt thereof for use in suppression of cerebellar atrophy.

(g) A method of suppressing cerebellar atrophy, comprising administering Compound A or a salt thereof to a patient.

(h) Use of Compound A or a salt thereof for producing an agent for suppressing cerebellar atrophy.

Advantageous Effects of Invention

[0009]

Brain atrophy, in particular cerebellar atrophy, can be suppressed and spinocerebellar ataxia can be prevented or treated by administering Compound A or a salt thereof.

Brief Description of Drawings

[0010]

[Figure 1] Figure 1 is a graph showing change in brain volume (the whole brain) at week 52 from that at screening in Test Example 1. "n.s." means that there was no statistically significant difference.

[Figure 2] Figure 2 is a graph showing change in brain volume (the hippocampus) at week 52 from that at screening in Test Example 1. "n.s." means that there was no statistically significant difference.

Embodiments for Carrying out the Invention

[0011]

Hereinafter the present invention will be described in detail.

In the present description, the respective terms have the following meaning unless otherwise specified.

[0012]

In the present description, the numerical range shown with "to" represents a range inclusive of the value before and after "to" as the minimum and maximum value, respectively.

[0013]

Compound A means 1-(3-(2-(1-benzothiophen-5-yl)ethoxy)propyl)azetidin-3-ol.

[0014]

Examples of salts of Compound A include known salts of a basic group such as amino group or an acidic group such as hydroxyl group or carboxyl group.

Examples of salts of a basic group include salts with a mineral acid such as hydrochloric acid, hydrogen bromide, nitric acid and sulfuric acid; salts with an organic carboxylic acid such as formic acid, acetic acid, citric acid, oxalic acid, fumaric acid, maleic acid, succinic acid, malic acid, tartaric acid, aspartic acid, trichloroacetic acid and trifluoroacetic acid; and salts with a sulfonic acid such as methanesulfonic acid, benzenesulfonic acid, p-toluenesulfonic acid, mesitylenesulfonic acid and naphthalenesulfonic acid.

[0015]

Examples of salts of an acidic group include salts with an alkali metal such as sodium and potassium; salts with an alkaline earth metal such as calcium and magnesium; ammonium salts; and salts with a nitrogen-containing organic base such as trimethylamine, triethylamine, tributylamine, pyridine, N,N-dimethylaniline, N-methylpiperidine, N-methylmorpholine, diethylamine, dicyclohexylamine, procaine, dibenzylamine, N-benzyl-β-phenethylamine, 1-efenamin and N,N'-dibenzylethylenediamine.

[0016]

Of the above salts, pharmacologically acceptable salts are preferred, and salts with maleic acid are more preferred.

[0017]

In the case where Compound A or a salt thereof has isomers (e.g., optical isomers, geometric isomers and tautomers), the present invention includes all these isomers and also includes hydrates, solvates and any crystal forms thereof.

[0018]

Prevention means to prevent the onset of a specific disease or at least one symptom caused by the disease.

Treatment means to reduce or improve at least one symptom caused by a specific disease with which a subject is affected, and delay the progress of the disease.

In an embodiment of the present invention, prevention means to inhibit or delay the onset or progress of spinocerebellar ataxia. Treatment means to inhibit or delay the progress of spinocerebellar ataxia.

In another embodiment of the present invention, prevention means to inhibit or delay the onset or progress of cerebellar atrophy. Treatment means to inhibit or delay the progress of cerebellar atrophy.

[0019]

Mild to moderate Alzheimer's disease may be clinically diagnosed as "probable AD" according to the diagnosis criteria provided by the National Institute of Neurological and Communicative Disorders and Stroke/the Alzheimer's Disease and Related Disorders Associations (NINCDS-ADRDA).

A usual doctor may reasonably make clinical diagnosis of "mild to moderate Alzheimer's disease" using standard criteria. For example, according to the score of the standardized Mini-Mental State Examination (MMSE, scores of 0 to 30), clinical diagnosis of mild to moderate, moderate, or moderate to severe AD is provided. The MMSE (Folstein, Folstein and McHugh, 1975) is a simple test of cognitive function including an interview with patients. Orientation, memory, calculation and attention, language skills and other functions are assessed. The total score is 30. The lower the score, the higher the level of impairment of cognitive function.

In Test Examples of the present invention, patients with an MMSE score of 12 to 22 at the start of the test (screening) were determined as mild to moderate AD. Note that the MMSE is not the only way to clinically determine the grade of AD, though convenient.

[0020]

Apolipoprotein E (ApoE), one of the apolipoproteins, constitutes lipoprotein and is involved in recognition of lipoprotein and lipid metabolism. ApoE has 3 isoforms of ApoE2, ApoE3 and ApoE4. A report shows that ApoE4 genotype encoding ApoE4 is corelated with the amount of deposition of amyloid-β protein in the brain and the ApoE4 genotype is a risk gene of Alzheimer's disease.

[0021]

Structural change in the brain is observed is also observed in normal aging, while cerebellar atrophy is a structural abnormality peculiar to spinocerebellar ataxia, which causes, for example, ataxia.

In an embodiment of the present invention, spinocerebellar ataxia includes, for example, hereditary olivopontocerebellar atrophy, hereditary cortical cerebellar atrophy, spinocerebellar ataxia type 1, spinocerebellar ataxia type 2, spinocerebellar ataxia type 3 (Machado-Joseph disease), spinocerebellar ataxia type 6, spinocerebellar ataxia type 31, hereditary dentatorubropallidoluysian atrophy, ataxia telangiectasia, Friedreich's ataxia, ataxia with vitamin E deficiency, aprataxin deficiency, senataxin deficiency, spastic ataxia of Charlevoix-Saguenay, hereditary spastic paraplegia, multiple system atrophy (olivopontocerebellar atrophy, Shy-Drager syndrome, striatonigral degeneration) and cortical cerebellar atrophy. Preferred are hereditary olivopontocerebellar atrophy, hereditary cortical cerebellar atrophy, spinocerebellar ataxia type 3 (Machado-Joseph disease), spinocerebellar ataxia type 6, spinocerebellar ataxia type 31 and cortical cerebellar atrophy.

Volumetric MRI (vMRI) enables in vivo assessment of brain structure volume, offering scales of the rate of atrophy.

[0022]

Compound A or a salt thereof used in the present invention may be prepared by a method known per se or by combining such methods, or by the method disclosed in Patent Literature 1.

[0023]

Compound A or a salt thereof used in the present invention may be blended with various pharmaceutical additives such as an excipient, a binding agent, a disintegrating agent, a disintegration inhibitor, a consolidation/adhesion-preventing agent, a lubricant, an absorption/adsorption carrier, a solvent, a bulking agent, an isotonic agent, a solubilizer, an emulsifier, a suspending agent, a thickener, a coating agent, an absorption enhancer, a gelling/procoagulant agent, a light stabilizer, a preservative, a desiccant, an emulsification/suspension/dispersion stabilizer, a color protecting agent, a deoxidant/antioxidant, a flavoring agent, a coloring agent, a foaming agent, an antifoaming agent, a soothing agent, an antistatic agent, a buffer, and/or a pH adjuster to give a pharmaceutical preparation such as an oral preparation (e.g., tablets, capsules, powders, granules, fine granules, pills, suspensions, emulsions, liquids, and syrups), injections, eye drops, nasal sprays and transdermal agents. Tablets are preferred as an oral dosage form for patients with AD.

The above agents are formulated by a usual method.

[0024]

The method of administration of Compound A, which is not particularly limited, is accordingly determined based on the form of the preparation, the age, sex and other conditions of the patient and the level of symptoms of the patient.

The dose of Compound A is accordingly selected based on the administration, the age, sex, type of disease and other conditions of the patient.

The agent may be administered to an adult in a dose or divided doses of usually 40 to 500 mg in terms of Compound A per day. The agent is administered in a dose or divided doses of preferably 100 to 400 mg in terms of Compound A per day, and administered in a dose of further preferably 160 mg or 320 mg in terms of Compound A per day.

[0025]

In the administration of Compound A or a salt thereof in the present invention, prevention or treatment by administration of acetylcholinesterase inhibitors (AChEIs) may also be included. Examples of AchEIs include donepezil hydrochloride, galantamine hydrochloride, rivastigmine tartrate and tacrine hydrochloride.

In the present invention, the subject may have undergone prevention or treatment by administration of AChEI for at least 6 months before administration of Compound A or a salt thereof.

[0026]

Next, the present invention will be described with reference to Test Examples and Preparation Examples, but the present invention is not limited thereto.

Maleate of Compound A was used as the test compound.

[0027]

Test Example 1 Multicenter randomized double-blind phase II placebo-controlled trial for assessing effectiveness and safety of Compound A in mild to moderate AD patients

Subject (selection criteria): Patients were screened in a period from 42 days before treatment assignment to the assignment based on the following selection criteria.

- Patients who were probable AD and are 55 years old or older and 85 years old or younger at the time of obtaining consent of screening.
- Patients with an MMSE score of 12 to 22 at the time of screening
- Patients with a Modified Hachinski Ischemia Scale score of 4 or less
- Patients who have been treated with a donepezil hydrochloride or rivastigmine transdermal system for at least 4 months before the baseline and with a stable dose thereof for 3 months before the baseline.
- In the case of patients who have received memantine in addition to being treated with a donepezil hydrochloride or rivastigmine transdermal system, patients who have been treated with memantine for at least 4 months before the baseline and with a stable dose thereof for 3 months before the baseline.
- Patients whose brain MRI or CT results match AD at the time of screening

Organization of groups: Patients matched (484 patients) were randomly divided into the following 3 groups and the trial was started.

(1) High dose group: 224 mg of a test compound (160 mg in terms of Compound A) was orally administered once a day for 4 weeks and then 448 mg of a test compound (320 mg in terms of Compound A) was orally administered once a day for 48 weeks (158 patients)

(2) Low dose group: 224 mg of a test compound (160 mg in terms of Compound A) was orally administered once a day for 52 weeks (166 patients)

(3) Placebo group: placebo was orally administered once a day for 52 weeks (158 patients)

Method of assessment:

Volumetric MRI

Brain volume of subjects was measured by vMRI scan at the screening and after 52 weeks, and the volume change of the whole brain and the hippocampus of the subjects were quantified to assess brain atrophy based on the change from the screening.

Furthermore, volume change of the whole brain and 101 areas (obtained by dividing the areas existing in both the left brain and the right brain of the Brodmann areas (1 to 52) into 101 areas) in each subject was quantified to assess brain atrophy based on the change from the screening.

Statistical analysis:

Changes in the volume of the whole brain and the hippocampus after 52 weeks from the baseline were compared between the high dose group and the placebo group, and between the low dose group and the placebo group based on Mixed-effect Models. For models, the treatment groups were included as a fixed effect, age, baseline of the respective brain volumes (the whole brain or the hippocampus), baseline of MMSE and ApoE4 genotype (positive/negative) were included as covariates, and trial sites were included as a random effect.

Furthermore, changes in the respective volumes of the whole brain and the 101 areas after 52 weeks from the baseline were compared between the high dose group and the placebo group, and between the low dose group and the placebo group.

Results: shown below

[0028]

Change in brain volume obtained by vMRI scan at week 52 from the baseline is shown in Table 1, Figure 1 and Figure 2.

[0029]

[Table 1]

Group	Number of cases/ statistics	Brain volume	
		Whole brain (mL)	Hippocampus (mL)
High dose group	Number of cases	76	76
	Least square means (standard error)	-20.05(3.821)	-0.31(0.057)
	Difference from placebo group (95% Confidence interval)	3.94(-2.91, 10.79)	0.08(-0.02, 0.18)
	p-value	0.2581	0.0996
Low dose group	Number of cases	79	79
	Least square means (standard error)	-21.37(3.582)	-0.27(0.053)
	Difference from placebo group (95% Confidence interval)	2.63(-4.15, 9.40)	0.12(0.03, 0.22)
	p-value	0.4456	0.0106
Placebo group	Number of cases	89	89
	Least square means (standard error)	-23.99(3.599)	-0.39(0.054)

[0030]

For the change in the volume of the whole brain and the hippocampus at week 52 from the baseline, volume reduction tended to be smaller in the Compound A group than in the placebo group. The difference in effects on the change in hippocampal volume between the Compound A low dose group and the placebo group was statistically significant.

[0031]

For change in brain volume obtained by vMRI scan at week 52 from the baseline, results for areas in which a statistically significant difference (p-value < 0.05) was found in the

comparison between the test compound low dose group and the placebo group are shown in Table 2.

[0032]

[Table 2]

No.	Placebo group		Low dose group		p-value	Brain area
	Mean value	Variance	Mean value	Variance		
1	-2.0490	1.0716	-0.9201	1.5655	0.0001	Left-Cerebellum-White-Matter
2	-0.6899	0.7012	-0.2695	0.6474	0.0005	Left-Cerebellum-Cortex
3	-2.9861	1.4550	-2.1332	1.4933	0.0013	ctx-rh-superior temporal
4	-1.6919	1.3679	-0.89	1.4082	0.0014	Right-Cerebellum-White-Matter)
5	-2.6470	1.4373	-1.9609	1.1486	0.0030	ctx-lh-insula
6	-1.5952	0.5635	-1.3142	0.5647	0.0054	Whole_brain
7	-2.6510	1.4746	-1.9976	1.1656	0.0056	ctx-rh-insula
8	-0.7248	0.8780	-0.3209	0.8541	0.0090	Right-Cerebellum-Cortex
9	-3.2601	1.4409	-2.6157	1.4466	0.0124	ctx-rh-inferior temporal)
10	-1.5322	1.4680	-0.8995	1.4382	0.0146	ctx-rh-lateral orbitofrontal
11	-1.4416	0.8598	-1.0753	0.8417	0.0157	Right-Cerebral-White-Matte)
12	-3.8173	2.1618	-2.97	1.9228	0.0195	ctx-lh-entorhinal
13	-1.5679	0.8570	-1.2418	0.7405	0.0215	Left-Cerebral-White-Matter
14	-3.0880	1.7450	-2.3402	1.9331	0.0232	Left-Hippocampus
15	-0.5499	1.5192	0.1244	1.9565	0.0323	ctx-lh-parsorbitalis

[0033]

In the Compound A low dose group, volume reduction of the cerebellum out of the whole brain and the 101 areas particularly tended to be suppressed compared to the placebo group (Nos. 1, 2, 4 and 8 in Table 2).

The same tendency as in the low dose group was observed in the Compound A high dose group.

[0034]

Preparation Example 1

0.9726 g of magnesium stearate (magnesium stearate, Merck) was added to 174.03 g of maleate of Compound A and the mixture was mixed for 30 minutes. The mixed powder was compression-molded by a roller compactor (TF-LABO (roll pressure 3 MPa), Freund Corporation), and the solid obtained by molding was granulated. 49.51 g of lactose (FlowLac 90, Meggle Japan), 16.50 g of crystalline cellulose (CEOLUS PH302, Asahi Kasei

Chemicals) and 6.67 g of croscarmellose sodium (Primellose, DMV Japan) were each sieved through a sieve with an opening of 850 μm and added to 60.0 g of the resulting granulated powder, and the mixture was mixed for 10 minutes. 0.6667 g of magnesium stearate was added to the mixed powder and the mixture was mixed for 30 minutes. The mixed powder was tableted by a tableting machine (HT-P18A, Hata Tekkosho) at a tableting pressure of about 12 kN using a pestle having a double rounded surface with a tablet diameter of 8.5 mm to obtain round uncoated tablets each weighing 250 mg. The uncoated tablets were coated with 8 mg of a coating agent per tablet using a film coater DRC-200 (Powrex), and then a small amount of carnauba wax (Polishing Wax-105, Nippon Wax) was added thereto to give film-coated tablets.

[0035]

Preparation Example 2

60.90 g of mannitol (Parteck M200, Merck) and 3.60 g croscarmellose sodium were added to 53.70 g of maleate of Compound A and the mixture was mixed for 10 minutes. 1.80 g of magnesium stearate was added to the mixed powder and the mixture was mixed for 30 minutes. The mixed powder was tableted at a tableting pressure of about 10 kN using a pestle having a double rounded surface with a tablet diameter of 8.5 mm to obtain round uncoated tablets each weighing 250 mg. The uncoated tablets were coated with 8 mg of a coating agent (Opadry 03F44057, 00F440000 (hypromellose 2910: 71.5%, Macrogol 6000: 14.166%, talc: 7.167%, titanium oxide: 7.067%, iron sesquioxide: 0.1%), Colorcon Japan LLC) per tablet, and then a small amount of carnauba wax was added thereto to give film-coated tablets.

[0036]

Preparation Example 3

11.11 g of magnesium stearate was added to 1988.89 g of maleate of Compound A and the mixture was mixed for 30 minutes. The mixed powder was compression-molded by a roller compactor, and the solid obtained by molding was granulated. To 107.13 g of the resulting granulated powder were added 26.21 g of mannitol, 7.50 g of ethyl cellulose (ETHOCEL 100FP Premium, The Dow Chemical Company), 3.75 g of crystalline cellulose

(CEOLUS KG-1000, Asahi Kasei Chemicals), 3.75 g of crospovidone (Kollidon CL-SF, BASF) and 0.75 g of croscarmellose sodium, and the mixture was mixed for 30 minutes. 0.90 g of magnesium stearate was added to the mixed powder and the mixture was mixed for 5 minutes. The mixed powder was tableted at a tableting pressure of about 7 kN using a pestle having a double rounded surface with a tablet diameter of 8.5 mm to obtain round uncoated tablets each weighing 315 mg. The uncoated tablets were coated with 9 mg of a coating agent per tablet, and then a small amount of carnauba wax was added thereto to give film-coated tablets.

CLAIMS

[Claim 1] An agent for preventing or treating spinocerebellar ataxia, comprising 1-(3-(2-(1-benzothiophen-5-yl)ethoxy)propyl)azetidin-3-ol or a salt thereof as an active ingredient.

[Claim 2] The agent for preventing or treating spinocerebellar ataxia according to claim 1, wherein the spinocerebellar ataxia is hereditary olivopontocerebellar atrophy, hereditary cortical cerebellar atrophy, spinocerebellar ataxia type 3 (Machado-Joseph disease), spinocerebellar ataxia type 6, spinocerebellar ataxia type 31 or cortical cerebellar atrophy.

[Claim 3] The agent for preventing or treating spinocerebellar ataxia according to claim 1 or 2, wherein the agent is for suppressing cerebellar atrophy in a patient with spinocerebellar ataxia.

[Claim 4] The agent for preventing or treating spinocerebellar ataxia according to claim 1 or 2, wherein the agent is for improving ataxia in a patient with spinocerebellar ataxia.

[Claim 5] The agent for preventing or treating spinocerebellar ataxia according to claim 1 or 2, wherein the agent is for improving balance disorder in a patient with spinocerebellar ataxia.

[Claim 6] The agent for preventing or treating spinocerebellar ataxia according to any one of claims 1 to 5, wherein the agent is orally administered in a dose of 100 mg to 400 mg in terms of 1-(3-(2-(1-benzothiophen-5-yl)ethoxy)propyl)azetidin-3-ol once a day.

[Claim 7] The agent for preventing or treating spinocerebellar ataxia according to any one of claims 1 to 5, wherein the agent is orally administered in a dose of 160 mg or 320 mg in terms of 1-(3-(2-(1-benzothiophen-5-yl)ethoxy)propyl)azetidin-3-ol once a day.