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(57) **Abrégé/Abstract:**

The present invention relates to methods for the treatment or prevention of depression, and related pharmaceutical compositions. Of particular interest are pharmaceutical compositions comprising cyclobenzaprine, alone, or in combination with an antidepressant drug.



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(54) Title: METHODS AND COMPOSITIONS FOR TREATING DEPRESSION USING CYCLOBENZAPRINE

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METHODS AND COMPOSITIONS FOR TREATING DEPRESSION USING CYCLOBENZAPRINE

5 FIELD OF THE INVENTION

The present invention relates to methods for the treatment or prevention of depression, and related pharmaceutical compositions. Of particular interest are pharmaceutical compositions comprising cyclobenzaprine, alone, or in combination with an
10 antidepressant drug.

BACKGROUND OF THE INVENTION

15 Cyclobenzaprine, or 3-(5H-dibenzo[a,d]cyclohepten-5-ylidene)-N,N-dimethyl-1-propanamine, was first approved by the U.S. Food and Drug Administration in 1977 for the treatment of acute muscle spasms of local origin. (Katz, W., et al., *Cyclobenzaprine in the Treatment of Acute Muscle Spasm: Review of a Decade of Clinical Experience*, *Clinical Therapeutics* 10:216-228 (1988)). Cyclobenzaprine has also been studied in the
20 treatment of fibromyalgia. In a study of 120 fibromyalgia patients, those receiving cyclobenzaprine (10 to 40 mg) over a 12-week period had significantly improved quality of sleep and pain score. There was also a reduction in the total number of tender points and muscle tightness.

25 Furthermore, the utility of a very low dose cyclobenzaprine as an agent for improving the quality of sleep, as a sleep deepener, or for treating sleep disturbances has been investigated. The very low dosage regimen was viewed as particularly useful in treating sleep disturbances caused by, exacerbated by or associated with fibromyalgia syndrome, prolonged fatigue, chronic fatigue, chronic fatigue syndrome, a sleep disorder, a
30 psychogenic pain disorder, chronic pain syndrome (type II), the administration of a drug, autoimmune disease, stress or anxiety or for treating an illness caused by or exacerbated

by sleep disturbances, and symptoms of such illness and generalized anxiety disorder.
See US Patent Nos. 6,395,788 and 6,358,944, herein incorporated by reference.

It is important to develop new methods and pharmaceutical compositions that ameliorate
5 depression with minimal side effects.

SUMMARY OF THE INVENTION

10 In one aspect the invention is a method for treating depression comprising administering
to a human in need of such treatment a pharmaceutical composition comprising
cyclobenzaprine in a therapeutically effective amount and a therapeutically effective
carrier, wherein such treatment ameliorates or eliminates the depression. Typically, the
cyclobenzaprine is administered at bedtime. Generally, the dose is less than 5 mg/day.
15 An antidepressant drug may be administered sequentially or concurrently. In a second
aspect the invention is a pharmaceutical composition comprising a therapeutically
effective amount of cyclobenzaprine in combination with an antidepressant drug.

20

DETAILED DESCRIPTION OF THE INVENTION

We have discovered that cyclobenzaprine treatment was associated with a significant
improvement in the HAD Depression subscore in fibromyalgia patients. The Hospital
25 Anxiety and Depression Scale (HAD) is a widely used patient self-rated scale with 14
questions (7 "anxiety" and 7 "depression" questions) that ranges from 0-42. Therefore,
we believe that a low dose cyclobenzaprine will be effective for treating depression,
including major depressive disorder. Thus, one aspect the invention is a method for
treating depression, including major depressive disorder, using a very low dose of
30 cyclobenzaprine.

"Cyclobenzaprine" includes cyclobenzaprine or a metabolite thereof, prodrug of cyclobenzaprine or a metabolite thereof. Metabolites of cyclobenzaprine useful according to the methods of this invention are metabolites that have substantially the same activity or better as cyclobenzaprine in alleviating depression symptoms.

5 Cyclobenzaprine metabolites that may be useful according to this invention include CBP 10,11-trans-dihydriol, N-desmethyl-2-hydroxycyclobenzaprine, 3-hydroxycyclobenzaprine, N-desmethylcyclobenzaprine cyclobenzaprine N-oxide or a chiral isomer of these metabolites. A prodrug of cyclobenzaprine is a derivative of cyclobenzaprine that is metabolized in vivo into the active agent. Prodrugs useful
10 according to this invention are those that have substantially the same activity or better than cyclobenzaprine in treating or preventing the symptoms of depression. Methods for making prodrugs are readily known in the art (e.g., Balant, L. P., *Prodrugs for the Improvement of Drug Absorption Via Different Routes of Administration*, Eur. J. Drug Metab. Pharmacokinet. 15:143-153 (1990); and Bundgaard, H., *Novel Chemical Approaches in Prodrug Design, Drugs of the Future* 16:443-458 (1991); incorporated by
15 reference herein).

As used herein, a "therapeutically effective amount" of cyclobenzaprine for the purposes of this invention refers to the amount of the compound that prevents or alleviates or
20 eliminates depression. A physician can readily determine when symptoms are prevented or alleviated or eliminated, for example through clinical observation of a subject, or through reporting of symptoms by the subject during the course of treatment. One skilled in the art can readily determine an effective amount of a cyclobenzaprine to be administered, by taking into account factors such as the size, weight, age and sex of the
25 subject, the extent of disease penetration or persistence and severity of symptoms, and the route of administration. Generally, a therapeutically effective amount of cyclobenzaprine administered to a subject is between 0.1mg to about 50 mg/day, between 0.5 to about 10 mg/day, between 1mg and 5mg/day, or between 1 and 4 mg/day. Higher or lower doses are also contemplated.

30

In one embodiment the cyclobenzaprine is administered at a very low dose to minimize side effects observed at higher doses. The low doses include doses of less than 5 mg/day or less than 2.5 mg/day. Even lower doses are also contemplated. Generally, cyclobenzaprine therapy can be carried out indefinitely to alleviate the symptoms of interest and frequency of dosage may be changed to be taken as needed. The period of treatment should be carried out for as long as necessary to alleviate depression symptoms and the cyclobenzaprine administered at night-time and at an appropriate dose. For example, the doses may be 1 mg/day, 2 mg/day, 3 mg/day or 4 mg/day.

10 In another embodiment of the invention, cyclobenzaprine is administered in combination with a drug which alleviates the symptoms of depression. The drugs may be administered sequentially or concurrently with the cyclobenzaprine. The drugs include an alpha-1-adrenergic receptor antagonist, a beta-adrenergic antagonist, an anticonvulsant, a selective serotonin reuptake inhibitor or a serotonin-norepinephrine reuptake inhibitor. Exemplary selective serotonin reuptake inhibitor or a serotonin-norepinephrine reuptake inhibitor include, but are not limited to, bupropion (at a dose between about 105 mg and 450 mg/day), citalopram (at a dose between about 10 mg and 40 mg/day), desvenlafaxine (at a dose between about 50 mg and 400 mg/day), duloxetine (at a dose between about 40 mg and 120 mg/day), escitalopram (at a dose between about 10 mg and 20 mg/day), fluoxetine (at a dose between about 20 mg and 80 mg/day), fluvoxamine (at a dose between about 100 mg and 300 mg/day), milnacipran (at a dose between about 30 mg and 200 mg/day), paroxetine (at a dose between about 20 mg and 50 mg/day), sertraline (at a dose between about 50 mg and 200 mg/day), tradodone (at a dose between about 150 mg and 600 mg/day), and venlafaxine (at a dose between about 75 mg and 225 mg/day). Exemplary anticonvulsants include, but are not limited to carbamazepine (at a dose between about 400 mg and 1200 mg/day), gabapentin (at a dose between about 900-1800 mg/day), lamotrigine (at a dose between about 100 mg and 400 mg/day), oxcarbazepine (at a dose between about 1200 mg and 2400 mg/day), pregabalin (at a dose between about 150 mg and 600 mg/day), tiagabine (at a dose between about 32 mg and 56 mg/day), topiramate (at a dose between about 200 mg and 400 mg/day), and valproate (at a dose between about 1200 mg and 1500 mg). Exemplary

alpha-1-adrenergic receptor antagonists include, but are not limited to, prazosin administered at a dose of between about 0.5mg to 15 mg/day.

Generally, the amount of cyclobenzaprine in the pharmaceutical composition is between
5 0.1 mg to about 50 mg, between 0.5 to about 30 mg, or between 1mg and 20mg. Higher or lower doses are also contemplated. In one particular embodiment the amount of cyclobenzaprine is very low to minimize side effects observed with higher amounts. The very low amounts are of less than 10 mg or less than 5 mg or less than 2.5 mg. Even lower amounts are also contemplated. In another embodiment of the invention,
10 cyclobenzaprine is combined with a drug which may further alleviate the symptoms of depression. The drugs include an alpha-1-adrenergic receptor antagonist, a beta-adrenergic antagonist, an anticonvulsant, a selective serotonin reuptake inhibitor or a serotonin-norepinephrine reuptake inhibitor. Exemplary anticonvulsants include, but are not limited to carbamazepine (400 mg to 1200 mg), gabapentin (900 mg to 1800 mg),
15 lamotrigine (100 mg to 400 mg), oxcarbazepine (1200 mg to 2400 mg), pregabalin (150 mg to 600 mg), tiagabine (32 mg to 56 mg), topiramate (200 mg to 400 mg), and valproate (1200 mg to 1500 mg). An exemplary alpha-1-adrenergic receptor antagonists includes, but is not limited to, prazosin in the amount of 0.5 mg to 15 mg. An exemplary selective serotonin reuptake inhibitor is escitalopram (in the amount of 10 mg and 20
20 mg).

Any suitable route of administration may be employed for providing the patient with an effective dosage of cyclobenzaprine. For example, buccal, oral, rectal, parenteral, transdermal, subcutaneous, sublingual, intranasal, intramuscular, intrathecal and the like
25 may be employed as appropriate. The term parenteral as used herein includes subcutaneous, intracutaneous, intravenous, intramuscular, intra-articular, intrasynovial, intrasternal, intrathecal, intralesional and intracranial injection or infusion techniques. Dosage forms include tablets, such as scored tablets, coated tablets, or orally dissolving tablets; thin films, caplets, capsules (e.g. hard gelatin capsules), troches, dragees,
30 dispersions, suspensions, solutions, patches and the like, including sustained release

formulations well known in the art. In one preferred embodiment, the dosage form is an orally dissolving tablet or a thin film.

By "pharmaceutically acceptable carrier" is meant any diluent or excipient that is
5 compatible with the other ingredients of the formulation, and which is not deleterious to the recipient. The pharmaceutically acceptable carrier can be selected on the basis of the desired route of administration, in accordance with standard pharmaceutical practices. Pharmaceutical compositions of the invention for parenteral administration can take the form of an aqueous or nonaqueous solution, dispersion, suspension or emulsion. In
10 preparing pharmaceutical compositions of the invention for parenteral administration, cyclobenzaprine can be mixed with a suitable pharmaceutically acceptable carrier such as water, oil (particularly a vegetable oil), ethanol, saline solutions (e.g., normal saline), aqueous dextrose (glucose) and related sugar solutions, glycerol, or glycols such as propylene glycol or polyethylene glycol. Pharmaceutical compositions of the invention
15 for parenteral administration preferably contain a water-soluble salt of cyclobenzaprine. Stabilizing agents, antioxidizing agents and preservatives can also be added to the pharmaceutical compositions for parenteral administration. Suitable antioxidizing agents include sulfite, ascorbic acid, citric acid and its salts, and sodium EDTA. Suitable preservatives include benzalkonium chloride, methyl- or propyl-paraben, and
20 chlorbutanol.

In preparing pharmaceutical compositions of the invention for oral administration, cyclobenzaprine can be combined with one or more solid or liquid inactive ingredients to form tablets, capsules, pills, powders, granules or other suitable oral dosage forms. For
25 example, cyclobenzaprine can be combined with at least one pharmaceutically acceptable carrier such as a solvent, filler, binder, humectant, disintegrating agent, solution retarder, absorption accelerator, wetting agent absorbent or lubricating agent. In one embodiment, cyclobenzaprine is combined with carboxymethylcellulose calcium, magnesium stearate, mannitol or starch, and is formed into tablets by conventional tableting methods.

30

Pharmaceutical compositions of the invention can be formulated so as to provide buccal absorption including thin film formulations and orally dissolving tablets to provide faster absorption than the oral/GI route and to bypass first-pass hepatic metabolism of cyclobenzaprine by cytochrome P-450 3A4 as a CYP3A substrate. Preferably, a
5 controlled-release pharmaceutical composition of the invention is capable of releasing cyclobenzaprine into a subject at a rapid onset, so as to maintain a substantially constant or desired pharmacological activity for a given period of time, reduce or remove the effect of food on absorption, and to provide elimination of the drug and metabolites from the body with a reduced terminal elimination phase.

10

Pharmaceutical compositions of the invention can also be formulated so as to provide controlled-release of cyclobenzaprine upon administration of the composition to a subject. Preferably, a controlled-release pharmaceutical composition of the invention is capable of releasing cyclobenzaprine into a subject at a desired rate, so as to maintain a
15 substantially constant or desired pharmacological activity for a given period of time.

As used herein, a "controlled-release component" is a compound such as a lipid or mixture of lipids, liposome and/or microsphere that induces the controlled-release of cyclobenzaprine into the subject upon exposure to a certain physiological compound or condition. For example, the controlled-release component can be biodegradable, activated
20 by exposure to a certain pH or temperature, by exposure to an aqueous environment, or by exposure to enzymes.

20

Formulation of controlled-release pharmaceutical compositions of the invention is within the skill in the art. Controlled release formulations suitable for use in the present
25 invention are described in, for example, U.S. Pat. No. 5,674,533 (liquid dosage forms), U.S. Pat. No. 5,591,767 (liquid reservoir transdermal patch), U.S. Pat. No. 5,120,548 (device comprising swellable polymers), U.S. Pat. No. 5,073,543 (ganglioside-liposome vehicle), U.S. Pat. No. 5,639,476 (stable solid formulation coated with a hydrophobic acrylic polymer), the entire disclosures of which are herein incorporated by reference.

30

Biodegradable microparticles can also be used to formulate controlled-release

pharmaceutical compositions suitable for use in the present invention, for example as described in U.S. Pat. Nos. 5,354,566 and 5,733,566, the entire disclosures of which are herein incorporated by reference.

5 In one embodiment, controlled-release pharmaceutical compositions of the invention comprise cyclobenzaprine and a controlled-release component. As used herein, a "controlled-release component" is a compound such as a polymer, polymer matrix, gel, permeable membrane, liposome and/or microsphere that induces the controlled-release of cyclobenzaprine into the subject upon exposure to a certain physiological compound or
10 condition. For example, the controlled-release component can be biodegradable, activated by exposure to a certain pH or temperature, by exposure to an aqueous environment, or by exposure to enzymes. An example of a controlled-release component which is activated by exposure to a certain temperature is a sol-gel. In this embodiment, cyclobenzaprine is incorporated into a sol-gel matrix that is a solid at room temperature.
15 This sol-gel matrix is implanted into a subject having a body temperature high enough to induce gel formation of the sol-gel matrix, thereby releasing the active ingredient into the subject.

In one embodiment, pharmaceutical compositions of the invention may comprise
20 cyclobenzaprine and components that form micelles. Micelles containing cyclobenzaprine in the stomach and proximal small intestine facilitate absorption. Example of a micelle-component which is activated by exposure to a certain temperature is found in US Patent Nos. 6,761,903; 6,720,001; 6,383,471; 6,309,663; 6,267,985; and 6,248,363, incorporated herein by reference. . In this embodiment, cyclobenzaprine is
25 incorporated into a soft-gel capsule. Such components may mimic the augmentation of absorption termed the "food effect", and such formulations may provide more predictable absorption by eliminating the "food effect" from dietary sources.

The composition of this invention may be administered by nasal aerosol or inhalation.
30 Such compositions are prepared according to techniques well-known in the art of pharmaceutical formulation and may be prepared as solutions in saline, employing benzyl

alcohol or other suitable preservatives, absorption promoters to enhance bioavailability, fluorocarbons, and/or other solubilizing or dispersing agents known in the art.

The magnitude of a prophylactic or therapeutic dose of the active ingredient (i.e.,
5 cyclobenzaprine or metabolite thereof) in the prevention or treatment of a human will vary with the type of affliction, the severity of the patient's affliction and the route of administration. The dose and dose frequency will also vary according to the age, weight and response of the individual patient. However, the dosage will not equal or exceed 5
10 mgs per day. In a preferred embodiment, one dose is given at bed time or up to several hours before bedtime to facilitate the achievement of deep, refreshing sleep. Bedtime may be any hour of the day at which a person engages in the most extensive period of sleep.

Any of the methods of treatment described above may be combined with
psychotherapeutic intervention to improve the outcome of the treatment. Of particular
15 interest is psychotherapeutic intervention directed at improvement in terms of reducing depression.

A pharmacogenomic test to measure cytochrome CYP3A4, CYP1A2, CYP3A and
CYP2G6 may be used to predict the metabolism of cyclobenzaprine by certain patients in
20 personalized medicine. Thus, the invention is a method for selecting an effective dose of cyclobenzaprine to be administered to a human in need of such treatment to correct for variations in cyclobenzaprine metabolism. The method comprises obtaining a genetic sample from said human and identifying the CYP1A2, CYP3A4, CYP3A or CYP2G6
25 genotype of said human, for example by using a gene chip or a PCR technique, to identify the alleles of one or more of the genes. Different alleles metabolize cyclobenzaprine at different speeds. For individuals having a cytochrome allele identified to metabolize cyclobenzaprine quickly a higher dose of cyclobenzaprine is administered. For individuals having an allele identified to metabolize cyclobenzaprine slowly a lower dose of cyclobenzaprine is administered. The genetic test can be sold as a
30 kit with the product to physicians/lab testing services. .

In order that this invention to be more fully understood, the following examples are set forth. These examples are for the purpose of illustration only and are not to be construed as limiting the scope of the invention in any way. The practice of the invention is
5 illustrated by the following non-limiting examples.

EXAMPLES

10 EXAMPLE 1 Tablet Formulation

A typical oral formulation for coated tablets consists of the following:

Formula quantity per tablet (mg.) cyclobenzaprine 1.0, lactose 74.0, corn starch 35.0,
water (per thousand tablets) 30.0 ml, magnesium stearate 1.0, corn starch 25.0

The active ingredient (cyclobenzaprine) is blended with the lactose until a uniform blend
15 is formed. The smaller quantity of corn starch is blended with a suitable quantity of water to form a corn starch paste. This is then mixed with the uniform blend until a uniform wet mass is formed. The remaining corn starch is added to the resulting wet mass and mixed until uniform granules are obtained. The granules are then screened through a suitable milling machine, using a 1/4 inch stainless steel screen. The milled granules are then
20 dried in a suitable drying oven until the desired moisture content is obtained. The dried granules are then milled through a suitable milling machine using 1/4 mesh stainless steel screen. The magnesium stearate is then blended and the resulting mixture is compressed into tablets of desired shape, thickness, hardness and disintegration.

25 Tablets are coated by standard aqueous or nonaqueous techniques. For example, 2.5 mg of hydroxypropymethylcellulose can be dissolved in 25 mg of deionized water. An aqueous (10 mg) suspension of 1.88 mg talc, 0.5 mg of titanium dioxide, 0.1 mg of yellow iron oxide, and 0.02 mg of red iron oxide is stirred into this solution. The coating suspension is sprayed on the tablets and the coated tablets are dried overnight at
30 45.degree. C.

EXAMPLE 2 Development of an Optimized Gelcap Formulation of VLD Cyclo for Depression.

We are developing a novel gelcap (KRL103) that employs a specific mixture of lipids to form micelles containing cyclobenzaprine that is expected to speed upper GI absorption, increase efficiency of absorption (in stomach and proximal small intestine); decrease or eliminate food effect (which is 20% for the Amrix formulation of cyclobenzaprine) and speed elimination (since lower GI absorption may prolong the terminal elimination phase in existing formulations). The gelcap formulation is expected to result in increased dosage precision; decreased potential for morning “hangover”; and potentially more rapid induction of sleep.

EXAMPLE 3 Treatment of Depression

Of 37 patients with fibromyalgia (American College of Rheumatology (ACR), 1990 criteria) in the screened population, 36 were randomized and 33 completed this 8-week, double-blind, placebo-controlled, dose-escalating study of very low dose cyclobenzaprine (VLD CBP) 1 – 4 mg at bedtime. We evaluated changes in subjective symptoms and objective sleep measures in the treated population (n=36) including: pain, tenderness (dolorimetry), fatigue, mood [Hospital Anxiety and Depression Scale (HAD)] and EEG sleep physiology (at screening, baseline and weeks 2, 4 and 8).

Hospital Anxiety and Depression Scale (HAD). The Hospital Anxiety and Depression Scale (HAD) is a widely used patient self-rated scale with 14 questions (7 “anxiety” and 7 “depression” questions) that ranges from 0-42. For subjects who received VLD CBP, the HAD score changed from 13.7 at baseline to 10.4 at week 8, which was a decrease (or improvement) of 3.3 (24.1%, p=0.012). In contrast, placebo treatment did not result in statistically significant changes in HAD scale, which was 15.7 at baseline and 15.1 at week 8 (-3.8%, p =0.459). Comparison of the change from baseline between the VLD CBP and placebo groups at week 8 did not reveal a significant effect of VLD CBP treatment on the HAD scale.

The HAD Depression Subscale score was also analyzed. For subjects who received VLD CBP, the HAD depression subscale changed from 6.3 at baseline to 4.9 at week 8, which was a decrease (or improvement) of 1.4 (22.2%, $p=0.017$). In contrast, placebo treatment did not result in statistically significant changes in intragroup HAD depression subscale, from 6.7 at baseline to 7.4 at week 8, which was an increase of 0.7 (10.4%, $p=0.319$). Comparison of the change from baseline between the VLD CBP and placebo groups at week 8 revealed that VLD CBP treatment was associated with a significant improvement in the HAD Depression subscore ($p= 0.023$).

10

All references cited herein are incorporated by reference. The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indication the scope of the invention.

15

I claim:

1. A method for treating depression comprising administering to a human in need of such treatment a pharmaceutical composition comprising cyclobenzaprine in a therapeutically effective amount and a therapeutically effective carrier, wherein such treatment ameliorates or eliminates the depression.
2. The method of claim 1, wherein the amount of cyclobenzaprine administered is less than 5 mg/day.
3. The method of claim 2, wherein the amount of cyclobenzaprine administered is less than 2.5 mg/day.
4. The method of claim 1, wherein the method further comprises administering sequentially or concurrently an antidepressant drug.
5. The method of claim 1, wherein the pharmaceutical composition is administered as an orally dissolving tablet or as a thin film formulation.
6. The method of claim 1, wherein the pharmaceutical composition is administered in combination with psychotherapeutic intervention.
7. The method of claim 1, wherein the pharmaceutical composition is administered at bedtime.
8. A pharmaceutical composition comprising a therapeutically effective amount of cyclobenzaprine in combination with an antidepressant drug.
9. The pharmaceutical composition of claim 8, wherein the amount of cyclobenzaprine is less than 5 mg.

10. The pharmaceutical composition of claim 9, wherein the amount of cyclobenzaprine is less than 2.5 mg.

5 11. The pharmaceutical composition of claim 8, wherein the pharmaceutical composition is an orally dissolving tablet or a thin film formulation.