and that samples are only taken from the patients after the metyrapone administration. Although metyrapone-IPSS improves the CRH-IPSS – since it dispenses with the need for sampling before the administration of metyrapone, and thus reduces the duration of catheterization and likelihood of infection, thrombis, or bleeding associated therewith – it also has serious limitations. First, metyrapone acts to block the conversion of 11-deoxycortisol to cortisol by 11β-hydroxylase, causing a decrease in cortisol level, which in turn stimulates ACTH production and release. Since its effect on the ACTH secretion is indirect, the test result may be skewed by other factors affecting the cortisol synthesis. Second, as a cortisol synthesis blocker, treatment of metyrapone – especially at a high dose – may result in adrenal insufficiency or have deleterious effects on various normal bodily functions that require cortisol – for example, the anti-stress and anti-inflammation functions. Third, metyrapone is currently not available in the United States, consequently this diagnosis method is out of reach for many patients in this country.

SUMMARY

[0006a] In one aspect of the present disclosure, there is provided a method of differentially diagnosing adrenocorticotropic hormone (ACTH)-dependent Cushing's syndrome in a patient where the differential diagnosis is between ectopic ACTH syndrome and Cushing's Disease, wherein:

(i) a patient with Cushing's syndrome and also elevated ACTH levels is selected;

(ii) a dose of glucocorticoid receptor antagonist (GRA) sufficient to increase ACTH from the pituitary gland by at least two fold in persons with normal Hypothalamus Pituitary Adrenal (HPA) function is to be administered to said patient; and

(iii) determining an ACTH concentration ratio from the patient wherein the ratio is derived from the ACTH concentrations in fluid obtained from either a left or right inferior petrosal venous sinus sample and from fluid obtained from a periphery venous sample two hours after administration of GRA;

wherein an ACTH concentration ratio of greater than 3 for the ACTH concentration from the inferior venous sinus sample over the periphery venous sinus sample is diagnostic of Cushing's disease.

[0006b] In another aspect of the present disclosure, there is provided a method of obtaining a measurement indicative of differential diagnosis of adrenocorticotropic hormone

(ACTH)-dependent Cushing's syndrome in a patient where the differential diagnosis is between ectopic ACTH syndrome and Cushing's disease, wherein:

a dose of glucocorticoid receptor antagonist (GRA) is to be administered to a patient with Cushing's syndrome and an elevated ACTH level,

where the amount of GRA to be administered to the patient is sufficient to increase ACTH from the pituitary gland by at least two fold in persons with normal Hypothalamus Pituitary Adrenal (HPA) function;

determining a ACTH concentration ratio from the patient,

wherein the ACTH concentration ratio is derived from the ACTH concentrations in fluid obtained from either a left or right inferior petrosal venous sinus sample and from fluid obtained from a periphery venous sample two hours after administration of GRA; and

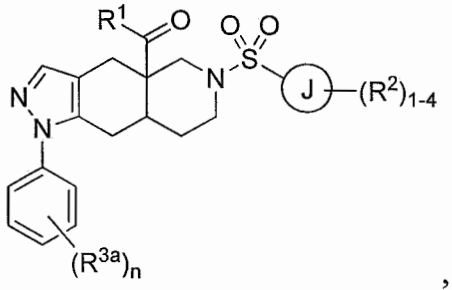
wherein an ACTH concentration ratio of greater than 3 for the ACTH concentration from the inferior venous sinus sample over the periphery venous sinus sample is indicative of Cushing's disease.

[0007] The present disclosure also relates to a method of differentially diagnosing adrenocorticotropic hormone (ACTH)-dependent Cushing's syndrome in a patient with hypercortisolemia where the differential diagnosis is between ectopic ACTH syndrome and Cushing Disease. The method comprises: (i) selecting a patient with Cushing's syndrome and elevated ACTH levels; (ii) administering a dose of glucocorticoid receptor antagonist (GRA) sufficient to increase ACTH from the pituitary gland by at least two fold in persons with normal HPA function; (iii) waiting for at least two hours; and (iv) obtaining from the patient an ACTH concentration ratio, which is derived both from the ACTH concentrations in fluid obtained from either the left or right inferior petrosal venous sinus and from fluid obtained from a periphery vein, e.g., a jugular vein. The patient is diagnosed with Cushing Disease if the ACTH concentration ratio is greater than 3.

[0008] In some embodiments, the periphery venous sample is a jugular venous sample. In some embodiments, the ratio is derived from the ACTH concentration in fluid obtained from the left and right inferior petrosal venous sinuses. In some embodiments, the GRA is a selective inhibitor of the glucocorticoid receptor. In some cases, the first and second

group consisting of hydrogen, halogen, and C_{1-6} haloalkyl; and subscript n is an integer from 0 to 3; or salts and isomers thereof.

[0013] In some cases, the octahydro fused azadecalin has the formula:



wherein R^1 is a heteroaryl ring having from 5 to 6 ring members and from 1 to 4 heteroatoms each independently selected from the group consisting of N, O, and S, optionally substituted with 1-4 groups each independently selected from R^{1a}; each R^{1a} is independently selected from the group consisting of hydrogen, C_{1-6} alkyl, halogen, C_{1-6} haloalkyl, C_{1-6} alkoxy, C_{1-6} haloalkoxy, N-oxide, and C_{3-8} cycloalkyl; ring J is selected from the group consisting of an aryl ring and a heteroaryl ring having from 5 to 6 ring members and from 1 to 4 heteroatoms each independently selected from the group consisting of N, O, and S; each R^2 is independently selected from the group consisting of hydrogen, C_{1-6} alkyl, halogen, C_{1-6} haloalkyl, C_{1-6} alkoxy, C_{1-6} haloalkoxy, C_{1-6} alkyl-C_{1-6} alkoxy, CN, OH, $NR^{2a}R^{2b}$, $C(O)R^{2a}$, $C(O)OR^{2a}$, $C(O)NR^{2a}R^{2b}$, SR^{2a}, $S(O)R^{2a}$, $S(O)_2R^{2a}$, C_{3-8} cycloalkyl, and C_{3-8} heterocycloalkyl having from 1 to 3 heteroatoms each independently selected from the group consisting of N, O, and S; alternatively, the two R^2 groups on adjacent ring atoms are combined to form a heterocycloalkyl ring having from 5 to 6 ring members and from 1 to 3 heteroatoms each independently selected from the group consisting of N, O, and S, wherein the heterocycloalkyl ring is optionally substituted with 1-3 R^{2c} groups; R^{2a}, R^{2b}, and R^{2c} are each independently selected from the group consisting of hydrogen and C_{1-6} alkyl; each R^{3a} is independently halogen; and subscript n is an integer from 0 to 3, or salts and isomers thereof.

[0014] In yet another embodiment, provided herein is a diagnostic composition, or a diagnostic kit comprising a glucocorticoid receptor antagonist (GRA) for use in a method of differentially diagnosing adrenocorticotropic hormone (ACTH)-dependent Cushing's syndrome in a patient where the differential diagnosis is between ectopic ACTH

syndrome and Cushing Disease, the method comprising the step of determining the ACTH concentration ratio from a patient with Cushing's syndrome and an elevated ACTH level, where the patient has been administered a dose of glucocorticoid receptor antagonist (GRA) at least two hours prior to the removal of venous samples and where the amount of GRA administered to the patient is sufficient to increase ACTH from the pituitary gland by at least two fold in persons with normal Hypothalamus Pituitary Adrenal (HPA) function; wherein the ACTH concentration ratio is derived from the ACTH concentrations in fluid obtained from either the left or right inferior petrosal venous sinus and from fluid obtained from a periphery venous sample; and wherein an ACTH concentration ratio of greater than 3 for the ACTH concentration from the inferior venous sinus sample over the periphery venous sinus sample is diagnostic indicative of Cushing's disease. In addition, all the embodiments in the first aspect described above are also included in this embodiment of the disclosure.

[0015] In yet another embodiment, provided here in is a method of obtaining a measurement indicative of differential diagnosis of adrenocorticotropic hormone (ACTH)-dependent Cushing's syndrome in a patient where the differential diagnosis is between ectopic ACTH syndrome and Cushing Disease, the method comprising the step of: (i)determining the ACTH concentration ratio from a patient with Cushing's syndrome and an elevated ACTH level, where the patient has been administered a dose of glucocorticoid receptor antagonist (GRA) at least two hours prior to the removal of venous samples and where the amount of GRA administered to the patient is sufficient to increase ACTH from the pituitary gland by at least two fold in persons with normal Hypothalamus Pituitary Adrenal (HPA) function; wherein the ACTH concentration ratio is derived from the ACTH concentrations in fluid obtained from either the left or right inferior petrosal venous sinus and from fluid obtained from a periphery venous sample; and wherein an ACTH concentration ratio of greater than 3 for the ACTH concentration from the inferior venous sinus sample over the periphery venous sinus sample is indicative of Cushing's disease. In addition, all the embodiments in the first aspect described above are also included in this embodiment of the disclosure.

[0016] In yet another embodiment, provided herein is a glucocorticoid receptor antagonist (GRA) for use in a method of differentially diagnosing adrenocorticotropic hormone (ACTH)-dependent Cushing's syndrome in a patient where the differential diagnosis is between ectopic ACTH syndrome and Cushing Disease, the method comprising the steps of: (i) selecting a patient with Cushing's syndrome and also elevated ACTH levels; (ii) administering a dose of the GRA sufficient to increase ACTH from the pituitary gland by at least two fold in persons with normal Hypothalamus Pituitary Adrenal (HPA) function; (iii) waiting for at least two hours; and (iv) obtaining from the patient an ACTH concentration ratio wherein the ratio is derived from the ACTH concentrations in fluid obtained from either the left or right inferior petrosal venous sinus and from fluid obtained from a periphery venous sample; wherein an ACTH concentration ratio of greater than 3 for the ACTH concentration from the inferior venous sinus sample over the periphery venous sinus sample is diagnostic of Cushing's disease. In addition, all the embodiments in the first aspect described above are also included in this embodiment of the disclosure.

[0017] Other objects, features, and advantages of the present disclosure will be apparent to one of skill in the art from the following detailed description and figures.

DETAILED DESCRIPTION OF THE INVENTION

I. INTRODUCTION

[0018] This invention involves the use of GRAs to provide a robust and reproducible means to stimulate ACTH production in the pituitary gland for the differential diagnosis of patients with ACTH-dependent Cushing's syndrome, where the differential diagnosis is between ectopic ACTH syndrome and Cushing Disease. GRAs are first administered, and blood samples are then taken by IPSS after sufficient time for the assessment of ACTH levels.

[0019] The claimed methods have many advantages over the existing differential diagnosis methods, such as CRH-IPSS, DDAVP-IPSS and metyrapone-IPSS. First, the claimed methods are more robust compared to metyrapone-IPSS. GRAs used in the

WHAT IS CLAIMED IS:

1. A method of differentially diagnosing adrenocorticotropic hormone (ACTH)-dependent Cushing's syndrome in a patient where the differential diagnosis is between ectopic ACTH syndrome and Cushing's Disease, wherein:

(i) a patient with Cushing's syndrome and also elevated ACTH levels is selected;

(ii) a dose of glucocorticoid receptor antagonist (GRA) sufficient to increase ACTH from the pituitary gland by at least two fold in persons with normal Hypothalamus Pituitary Adrenal (HPA) function is to be administered to said patient; and

(iii) determining an ACTH concentration ratio from the patient wherein the ratio is derived from the ACTH concentrations in fluid obtained from either a left or right inferior petrosal venous sinus sample and from fluid obtained from a periphery venous sample two hours after administration of GRA; wherein an ACTH concentration ratio of greater than 3 for the ACTH concentration from the inferior venous sinus sample over the periphery venous sinus sample is diagnostic of Cushing's disease.

2. The method of claim 1 wherein the periphery venous sample is a jugular venous sample.

3. The method of claim 1 wherein the glucocorticoid receptor antagonist is a selective inhibitor of the glucocorticoid receptor.

4. The method of claim 1 wherein a first and second sampling of the ACTH concentrations in the are taken 5-10 minutes apart from both the inferior petrosal venous sinus and a periphery venous sample.

5. The method of claim 1, wherein the glucocorticoid receptor antagonist comprises a steroidal backbone with at least one phenyl-containing moiety in the 11-β position of the steroidal backbone.

6. The method of claim 5 wherein the phenyl-containing moiety in the 11-β position of the steroidal backbone is a dimethylaminophenyl moiety.

7. The method of claim 5, wherein the glucocorticoid receptor antagonist is mifepristone.

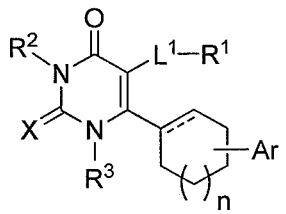
8. The method of claim 1, wherein the glucocorticoid receptor antagonist is selected from the group consisting of 11β-(4-dimethylaminoethoxyphenyl)-17α-propynyl-17β-hydroxy-4,9 estradien-3-one and (17α)-17-hydroxy-19-(4-methylphenyl)androsta-4,9(11)-dien-3-one.

9. The method of claim 1, wherein the glucocorticoid receptor antagonist is (11β,17β)-11-(1,3-benzodioxol-5-yl)-17-hydroxy-17-(1-propynyl)estra-4,9-dien-3-one.

10. The method of claim 1, wherein the glucocorticoid receptor antagonist has a non-steroidal backbone.

11. The method of claim 10, wherein the glucocorticoid receptor antagonist backbone is a cyclohexyl pyrimidine.

12. The method of claim 11, wherein the cyclohexyl pyrimidine has the following formula:



wherein

the dashed line is absent or a bond;

X is selected from the group consisting of O and S;

R^1 is selected from the group consisting of cycloalkyl, heterocycloalkyl, aryl and heteroaryl, optionally substituted with from 1 to 3 R^{1a} groups;

each R^{1a} is independently selected from the group consisting of H, C_{1-6} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{1-6} alkoxy, C_{1-6} alkyl OR^{1b}, halogen, C_{1-6} haloalkyl, C_{1-6} haloaloxy, OR^{1b}, $NR^{1b}R^{1c}$, $C(O)R^{1b}$, $C(O)OR^{1b}$, $OC(O)R^{1b}$, $C(O)NR^{1b}R^{1c}$, $NR^{1b}C(O)R^{1c}$, SO_2R^{1b}, $SO_2NR^{1b}R^{1c}$, cycloalkyl, heterocycloalkyl, aryl and heteroaryl;

R^{1b} and R^{1c} are each independently selected from the group consisting of H and C_{1-6} alkyl;

R^2 is selected from the group consisting of H, C_{1-6} alkyl, C_{1-6} alkyl-OR^{1b}, C_{1-6} alkyl $NR^{1b}R^{1c}$ and C_{1-6} alkylene heterocycloalkyl;

R^3 is selected from the group consisting of H and C_{1-6} alkyl;

Ar is aryl, optionally substituted with 1-4 R^4 groups;

each R^4 is independently selected from the group consisting of H, C_{1-6} alkyl, C_{1-6} alkoxy, halogen, C_{1-6} haloalkyl and C_{1-6} haloalkoxy;

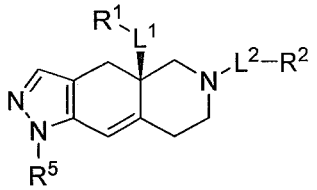
L^1 is a bond or C_{1-6} alkylene; and

subscript n is an integer from 0 to 3,

or salts thereof.

13. The method of claim 10, wherein the glucocorticoid receptor antagonist backbone is a fused azadecalin.

14. The method of claim 13, wherein the fused azadecalin is a compound having the following formula:



wherein

L^1 and L^2 are members independently selected from a bond and unsubstituted alkylene;

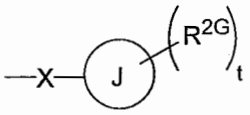
R^1 is a member selected from unsubstituted alkyl, unsubstituted heteroalkyl, unsubstituted heterocycloalkyl, $-OR^{1A}$, $NR^{1C}R^{1D}$, $-C(O)NR^{1C}R^{1D}$, and $-C(O)OR^{1A}$, wherein

R^{1A} is a member selected from hydrogen, unsubstituted alkyl and unsubstituted heteroalkyl,

R^{1C} and R^{1D} are members independently selected from unsubstituted alkyl and unsubstituted heteroalkyl,

wherein R^{1C} and R^{1D} are optionally joined to form an unsubstituted ring with the nitrogen to which they are attached, wherein said ring optionally comprises an additional ring nitrogen;

R^2 has the formula:



wherein

R^{2G} is a member selected from hydrogen, halogen, unsubstituted alkyl, unsubstituted heteroalkyl, unsubstituted cycloalkyl, unsubstituted heterocycloalkyl, -CN, and $-CF_3$;

J is phenyl;

t is an integer from 0 to 5;

X is $-S(O_2)-$; and

R^5 is phenyl optionally substituted with 1-5 R^{5A} groups, wherein

R^{5A} is a member selected from hydrogen, halogen, $-OR^{5A1}$, $S(O_2)NR^{5A2}R^{5A3}$, -CN, and unsubstituted alkyl, wherein

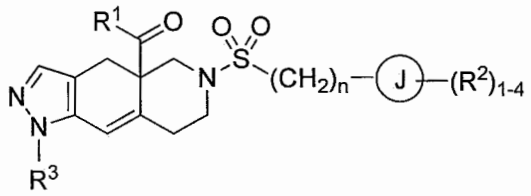
R^{5A1} is a member selected from hydrogen and unsubstituted alkyl, and

R^{5A2} and R^{5A3} are members independently selected from hydrogen and unsubstituted alkyl,

or salts thereof.

15. The method of claim 10, wherein the glucocorticoid receptor antagonist backbone is a heteroaryl ketone fused azadecalin or an octahydro fused azadecalin.

16. The method of claim 15, wherein the heteroaryl ketone fused azadecalin has the formula:

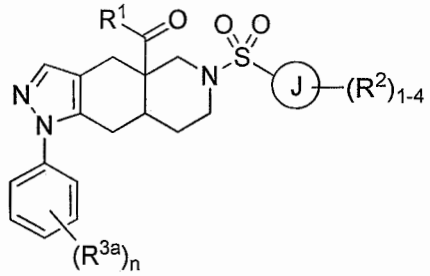


each R^{3a} is independently selected from the group consisting of hydrogen, halogen, and C_{1-6} haloalkyl; and

subscript n is an integer from 0 to 3;

or salts thereof.

17. The method of claim 15, wherein the octahydro fused azadecalin has the formula:



wherein

R^1 is a heteroaryl ring having from 5 to 6 ring members and from 1 to 4 heteroatoms each independently selected from the group consisting of N, O and S, optionally substituted with 1-4 groups each independently selected from R^{1a};

each R^{1a} is independently selected from the group consisting of hydrogen, C_{1-6} alkyl, halogen, C_{1-6} haloalkyl, C_{1-6} alkoxy, C_{1-6} haloalkoxy, N-oxide, and C_{3-8} cycloalkyl;

ring J is selected from the group consisting of an aryl ring and a heteroaryl ring having from 5 to 6 ring members and from 1 to 4 heteroatoms each independently selected from the group consisting of N, O and S;

each R^2 is independently selected from the group consisting of hydrogen, C_{1-6} alkyl, halogen, C_{1-6} haloalkyl, C_{1-6} alkoxy, C_{1-6} haloalkoxy, C_{1-6} alkyl-C_{1-6} alkoxy, CN, OH, $NR^{2a}R^{2b}$, $C(O)R^{2a}$, $C(O)OR^{2a}$, $C(O)NR^{2a}R^{2b}$, SR^{2a}, $S(O)R^{2a}$, $S(O)_2R^{2a}$, C_{3-8} cycloalkyl, and C_{3-8} heterocycloalkyl having from 1 to 3 heteroatoms each independently selected from the group consisting of N, O and S;

alternatively, two R^2 groups on adjacent ring atoms are combined to form a heterocycloalkyl ring having from 5 to 6 ring members and from 1 to 3 heteroatoms each independently selected from the group consisting of N, O and S, wherein the heterocycloalkyl ring is optionally substituted with from 1 to 3 R^{2c} groups;

R^{2a}, R^{2b} and R^{2c} are each independently selected from the group consisting of hydrogen and C_{1-6} alkyl;

each R^{3a} is independently halogen; and

subscript n is an integer from 0 to 3,

or salts thereof.

18. A method of obtaining a measurement indicative of differential diagnosis of adrenocorticotropic hormone (ACTH)-dependent Cushing's syndrome in a patient where the differential diagnosis is between ectopic ACTH syndrome and Cushing's disease, wherein:
a dose of glucocorticoid receptor antagonist (GRA) is to be administered to a patient with Cushing's syndrome and an elevated ACTH level,
where the amount of GRA to be administered to the patient is sufficient to increase ACTH from the pituitary gland by at least two fold in persons with normal Hypothalamus Pituitary Adrenal (HPA) function;
determining a ACTH concentration ratio from the patient,
wherein the ACTH concentration ratio is derived from the ACTH concentrations in fluid obtained from either a left or right inferior petrosal venous sinus sample and from fluid obtained from a periphery venous sample two hours after administration of GRA; and
wherein an ACTH concentration ratio of greater than 3 for the ACTH concentration from the inferior venous sinus sample over the periphery venous sinus sample is indicative of Cushing's disease.