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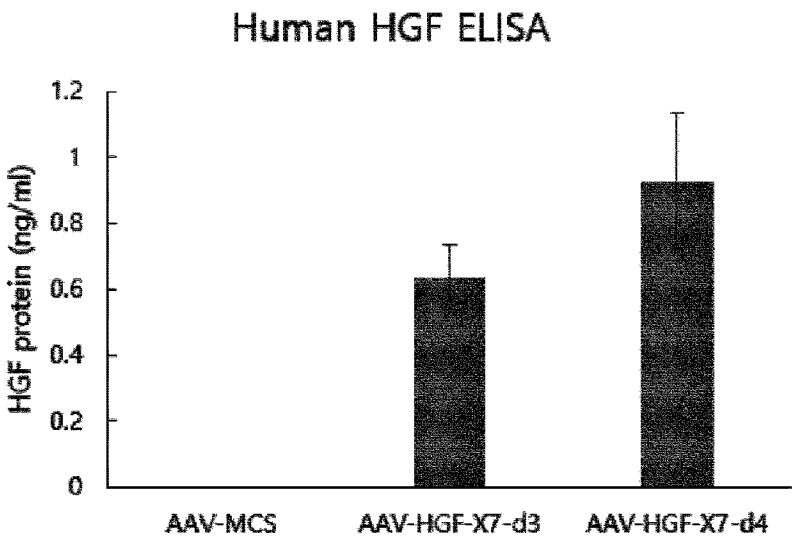
(54) Titre : VECTEUR DE VIRUS ADENO-ASSOCIE (VAA) COMPRENANT UN GENE HGF HYBRIDE INTRODUIT EN SON SEIN

(54) Title: ADENO-ASSOCIATED VIRUS (AAV) VECTOR HAVING HYBRID HGF GENE INTRODUCED THERETO



(57) Abrégé/Abstract:
The present invention relates to an AAV vector carrying a predetermined hybrid HGF gene sequence. Use of the AAV vector of the present invention allows a hybrid HGF gene to be delivered to a subject at a high delivery yield.

Abstract

The present invention relates to an AAV vector carrying a predetermined hybrid HGF gene sequence. Use of the AAV vector of the present invention allows a hybrid HGF gene to be delivered to a subject at a high delivery yield.

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ADENO-ASSOCIATED VIRUS (AAV) VECTOR HAVING HYBRID HGF GENE INTRODUCED THERETO

Technical Field

The present invention relates to an AAV vector comprising a predetermined hybrid HGF gene sequence.

Background Art

Gene therapy is a method in which therapeutic genes are delivered into cells of patients using gene recombinant technology to induce genetic mutations of target cells or express particular proteins, thereby treating genetic diseases, incurable diseases, and the like. Substances that carry the genes into living bodies are called carriers or vectors. Vectors are largely classified into viral vectors and non-viral vectors. Retroviruses and adenoviruses are representative types of viral vectors, and non-viral vectors include naked DNA, liposomes, and the like.

Hepatocyte growth factor (HGF) is one of the growth factors, and research on various functions of HGF is ongoing. Examples thereof are as follows: (1) the treatment of heart disease by HGF using liposome as carrier (Aoki et al., Angiogenesis induced by hepatocyte growth factor in non-infarcted myocardium and infracted myocardium: up-regulation of essential transcription factor for angiogenesis, etc. *Gene Therapy* 7:417-427, 2000); (2) the treatment of liver disease by HGF using AAV as carrier (Suzumura et al., Adeno-associated virus vector-mediated production of hepatocyte growth factor

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attenuates liver fibrosis in mice. *Hepatol.* Int. 2:80-88, 2008); (3) the treatment of diabetic peripheral neuropathy by HGF using naked DNA as carrier (Kessler et al., Double-blind, placebo-controlled study of HGF gene therapy in diabetic neuropathy. *Annals of Clinical and Translational Neurology* 2:465-478, 2015); and (4) the treatment of amyotrophic lateral sclerosis by HGF using naked DNA as carrier (Sufit et al., Open label study to assess the safety of VM202 in subjects with amyotrophic lateral sclerosis. Amyotroph Lateral Scler Frontotemporal Degener 18:269-278, 2017).

Detailed Description of the Invention

Technical Problem

The present inventors have researched and endeavored to develop a gene delivery system with increased delivery efficiency of a hybrid HGF gene that simultaneously expresses hepatocyte growth factor (HGF) isoforms including flHGF and dHGF. As a result, the present inventors have established that gene delivery efficiency can be significantly improved when a downsized mutant of a previously known hybrid HGF gene and adeno-associated virus (AAV) as a gene delivery system are used, and thus have completed the present invention.

Therefore, an aspect of the present invention is to provide an adeno-associated virus (AAV) vector into which a foreign nucleic acid sequence consisting of a predetermined nucleotide sequence is introduced.

Another aspect of the present invention is to provide a transformant transformed with the above-described AAV vector.

Still another aspect of the present invention is to provide a composition comprising the above-described AAV vector for the prevention or treatment of diabetic

peripheral neuropathy (DPN) or amyotrophic lateral sclerosis (ALS).

Other purposes and advantages of the present disclosure will become more obvious when taken with the following detailed description of the invention, claims, and drawings.

Technical Solution

In accordance with an aspect of the present invention, there is provided an adeno-associated virus (AAV) vector, into which a foreign nucleic acid sequence consisting of the nucleotide sequence of SEQ ID NO: 5 is introduced.

The present inventors have researched and endeavored to develop a gene delivery system with increased delivery efficiency of a hybrid HGF gene that simultaneously expresses hepatocyte growth factor (HGF) isoforms including flHGF and dHGF. As a result, the present inventors have established that gene delivery efficiency can be significantly improved when a downsized mutant of a previously known hybrid HGF gene and adeno-associated virus (AAV) as a gene delivery system are used.

As used herein, the term "hybrid HGF gene" refers to a gene sequence that simultaneously expresses two or more HGF isoforms by selective splicing. More specifically, the above-described two or more HGF isoforms include at least a full-length HGF (flHGF) isoform and a deleted variant HGF (dHGF) isoform.

Due to the degeneracy of codons or considering preferred codons in an organism where the HGF and dHGF genes are to be expressed, the hybrid HGF gene of the present invention may have various alterations in a coding region within the range that does not change the amino acid sequence of a protein expressed from the

coding region, or may also have various alterations or modifications in a region other than the coding region within a range that does not affect the expression of the gene, and such altered or modified genes are also included in the scope of the present invention. Therefore, the present invention also includes a polynucleotide having substantially the same nucleotide sequence as the hybrid HGF gene of SEQ ID NO: 5, and fragments of the gene. The substantially the same polynucleotide means a polynucleotide having a sequence homology of at least 80%, preferably at least 90%, and the most preferably at least 95%.

The above-described hybrid HGF gene may include cDNA, corresponding to exons 1 to 18 of the human HGF gene and intron 4 of the human HGF gene, inserted between exons 4 and 5 of the cDNA, or fragments thereof. This sequence is known to be HGF-X7 consisting of the nucleotide sequence of SEQ ID NO: 6 (see KR 2017-0024614 (published on 7 March 2017)). However, when inserted into an AAV vector, the above-described nucleotide sequence of SEQ ID NO: 6 has size-related limitations. The nucleotide sequence of SEQ ID NO: 5 of the present invention corresponds to a sequence showing significantly increased gene delivery efficiency among sequences which are downsized by removing a part of the sequence corresponding to the intron 4 fragment of the nucleotide sequence of SEQ ID NO: 6. Specifically, the delivery of the nucleotide sequence of SEQ ID NO: 5 to a subject through introduction into an AAV vector shows significantly increased gene delivery efficiency and expression efficiency compared with the use of the previously known HGF-X8 of SEQ ID NO: 7 through introduction into the AAV vector.

A polynucleotide may be delivered to a subject in a naked DNA state or a state of being contained in a gene

delivery system. It has been known that a plasmid, a viral vector, or the like may be used as a gene delivery system, but, as described above, an adeno-associated virus (AAV) vector is used as a gene delivery system in the present invention.

AAA vectors may infect non-dividing cells and may infect various kinds of cells. Detailed descriptions of the construction and use of AAA vectors are disclosed in U.S. Patent No. 5,139,941 and No. 4,797,368. The research results on AAV as a gene delivery system are disclosed in LaFace et al, Virology, 162:483486 (1988), Zhou et al., Exp. Hematol. (NY), 21:928-933 (1993); Walsh et al, J. Clin. Invest., 94:1440-1448 (1994); and Flotte et al., Gene Therapy, 2:29-37 (1995). Typically, AAV viruses are produced by co-transfection of a plasmid comprising a target gene sequence flanked by two AAV terminal repeats (McLaughlin et al., J. Virol., 62:1963-1973 (1988); and Samulski et al., J. Virol., 63:3822-3828 (1989)), an expression plasmid comprising a wild-type AAV coding sequence without terminal repeats, and a plasmid comprising an adenovirus helper gene (McCarty et al., J. Virol., 65:2936-2945 (1991)).

The AAV vector of the present invention may be used to deliver a foreign gene sequence into cells by various viral infection methods known in the art, and the methods are not particularly limited.

The AAV vector of the present invention has an AAV serotype selected from the group consisting of AAV1, AAV2, AAV3, AAV4, AAV5, AAV6, AAV7, AAV8, AAV9, AAV10, AAV11, AAV12, AAV13, AAV14, AAV15, and AAV16.

According to another aspect of the present invention, the present invention provides a transformant transformed with the above-described AAV vector.

The AAV vector of the present invention can be introduced into appropriate host cells, for example,

mammalian cells, such as 293T cells, or insect cells, or the like, and the transformed host cells can be used to make mass-replication of DNA of the gene of the present invention or mass-production of a protein thereof.

In accordance with an aspect of the present invention, there is provided a composition comprising the above-described AAV vector for prevention or treatment of diabetic peripheral neuropathy (DPN) or amyotrophic lateral sclerosis (ALS).

As used herein, the term "prevention" refers to all acts of suppressing diabetic peripheral neuropathy or amyotrophic lateral sclerosis through administration of the composition of the present invention.

As used herein, the term "treatment" refers to (a) the delay or suppression of the progression/development of diabetic peripheral neuropathy or amyotrophic lateral sclerosis; (b) the relief of diabetic peripheral neuropathy or amyotrophic lateral sclerosis; and (c) the removal of diabetic peripheral neuropathy or amyotrophic lateral sclerosis.

The composition of the present invention may comprise a pharmaceutically acceptable carrier.

The pharmaceutically acceptable carrier contained in the pharmaceutical composition of the present invention is one that is typically used for formulation, and examples thereof may include, but are not limited to, lactose, dextrose, sucrose, sorbitol, mannitol, starch, acacia gum, calcium phosphate, alginate, gelatin, calcium silicate, microcrystalline cellulose, polyvinylpyrrolidone, cellulose, water, syrup, methyl cellulose, methyl hydroxybenzoate, propyl hydroxybenzoate, talc, magnesium stearate, and mineral oils. The pharmaceutical composition of the present invention may further comprise, in addition to the above ingredients, a lubricant, a wetting agent, a sweetening

agent, a flavoring agent, an emulsifier, a suspending agent, a preservative, and the like. Suitable pharmaceutically acceptable carriers and preparations are described in detail in *Remington's Pharmaceutical Sciences* (19th ed., 1995).

The pharmaceutical composition of the present invention may be preferably administered parenterally, and for example, intravenous administration, intraperitoneal administration, intramuscular injection, subcutaneous administration, intrathecal administration, intracerebroventricular injection, intracerebral injection, or topical administration may be used.

The pharmaceutical composition of the present invention may be formulated and administered as an injection. The appropriate dose of the pharmaceutical composition of the present invention varies depending on factors, such as the method of formulation, the manner of administration, the patient's age, body weight, and gender, the severity of disease symptoms, the time of administration, the route of administration, the excretion rate, and response sensitivity. An ordinarily skilled practitioner can easily determine and prescribe the dose effective for desired treatment. According to an embodiment of the present invention, the AAV vector of the present invention is administered in an amount of 1×10^{8} to 1×10^{12} GC/site.

The pharmaceutical composition of the present invention is formulated using a pharmaceutically acceptable carrier and/or excipient according to a method that could be easily performed by a person having ordinary skills in the art to which the present invention pertains, and the pharmaceutical composition may be prepared into a unit dosage form, or may be inserted into a multi-dose container. The formulation may be in the form of a solution, suspension, or

emulsion in an oily or aqueous medium, or an extract, a powder, granules, a tablet, or a capsule, and the formulation may further comprise a dispersant or a stabilizer.

In an embodiment of the present invention, the above-described diabetic peripheral neuropathy is polyneuropathy or focal neuropathy.

In an embodiment of the present invention, the foregoing polyneuropathy is at least one diabetic peripheral neuropathy selected from the group consisting of hyperglycemic neuropathy, distal symmetric polyneuropathy, autonomic neuropathy, acute sensory neuropathy, acute painful sensory neuropathy, and chronic sensorimotor neuropathy. More specifically, the foregoing focal neuropathy is at least one diabetic peripheral neuropathy selected from the group consisting of cranial neuropathy, truncal neuropathy, limb neuropathy, thoracolumbar radiculoneuropathy, and lumbosacral radiculoplexus neuropathy.

Advantageous Effects

Features and advantages of the present invention are summarized as follows.

(a) The present invention provides an adeno-associated virus (AAV) vector, into which a foreign nucleic acid sequence consisting of a predetermined nucleotide sequence is introduced.

(b) The present invention provides a transformant transformed with the above-described AAV vector.

(c) The present invention provides a composition comprising the above-described AAV vector for prevention or treatment of diabetic peripheral neuropathy (DPN) or amyotrophic lateral sclerosis (ALS).

(d) The use of the AAV vector of the present invention can deliver a hybrid HGF gene to a subject

with high delivery efficiency.

Brief Description of the Drawings

FIG. 1 is a schematic diagram showing a method for preparing downsized mutants of HGF-X7 from pCK-HGF-X7.

FIG. 2 is a schematic diagram showing a method for cloning downsized mutants of HGF-X7 into pCA vectors.

FIG. 3 is a graph showing the expression level of HGF protein in C2C12 cells infected with AAV-pCA-HGF-X7-d3 and AAV-pCA-HGF-X7-d4, respectively.

FIG. 4 is a graph showing the expression level of HGF protein in C2C12 cells infected with AAV2-pCA-HGF-X7-d4 and AAV2-pCA-HGF-X8.

FIG. 5 is a graph showing a delay of progression of disease after intramuscular injection of AAV6-pCA-HGF-X7-d4 in ALS mice.

FIG. 6 is a graph showing the degree of improvement in survival rate after intramuscular injection of AAV6-pCA-HGF-X7-d4 in ALS mice.

FIG. 7 is a graph showing the degree of slowdown in weight loss after intramuscular injection of AAV6-pCA-HGF-X7-d4 in ALS mice.

FIG. 8 depicts graphs showing the results of survival rate investigation and behavioral test analysis after intrathecal administration of AAV1-pCA-HGF-X7-d4 in ALS mice.

Mode for Carrying Out the Invention

Hereinafter, the present invention will be described in more detail with reference to examples. These examples are only for illustrating the present invention more specifically, and it will be apparent to those skilled in the art that the scope of the present invention is not limited by these examples according to the gist of the present invention.

EXAMPLES

Test Example 1: Preparation of HGF-X7 derivatives

To construct an AAV vector expressing two isoforms of HGF, four derivatives were prepared from SEQ ID NO: 1 (pCK-HGF-X7) through site-directed mutagenesis. The detailed description of the method is as follows. First, PCR (site-directed mutagenesis kit, Stratagene, US) was performed using DNA of SEQ ID NO: 1 as a template. The primer sequences that were used are as follows.

[TABLE 1]

d1	Forward (SEQ ID NO: 8)	TCTCGGTATTTGTGGATCCTATTATGATCTTTTGTGTAAA
	Reverse (SEQ ID NO: 9)	TTTACACAAAAGATCATAATAGGATCCACAAATACCGAGA
d2	Forward (SEQ ID NO: 10)	TCTCGGTATTTGTGGATCCTTTACTATTATAAACCAAAAC
	Reverse (SEQ ID NO: 11)	GTTTTGGTTTATAATAGTAAAGGATCCACAAATACCGAGA
d3	Forward (SEQ ID NO: 12)	TCTCGGTATTTGTGGATCCTAAGGTGTAAGATGTTAAAGG
	Reverse (SEQ ID NO: 13)	CCTTTAACATCTTACACCTTAGGATCCACAAATACCGAGA
d4	Forward (SEQ ID NO: 14)	TCTCGGTATTTGTGGATCCTTATAAGAAAAGCAATAAACA
	Reverse (SEQ ID NO: 15)	TGTTTATTGCTTTTCTTATAAGGATCCACAAATACCGAGA

Out of the colonies obtained by delivering PCR products to C cells, colonies containing pCK-HGF-X7-d1, pCK-HGF-X7-d2, pCK-HGF-X7-d3, and pCK-HGF-X7-d4 were selected, and plasmid DNA was extracted therefrom (see FIG. 1).

Test Example 2: Construction of pCA-HGF-X7 derivatives

For the production of AAVs containing the four derivatives obtained in Test Example 1, theses derivatives were cloned into respective pCA vectors (AAV

helper-free system, Agilent, USA). First, pCK-HGF-X7-d1, pCK-HGF-X7-d2, pCK-HGF-X7-d3, and pCK-HGF-X7-d4 in Test Example 1 were digested with ClaI and SalI restriction enzymes to give four types of fragments, HGF-X7-d1, HGF-X7-d2, HGF-X7-d3, and HGF-X7-d4. The pCA vectors were also digested with ClaI and SalI restriction enzymes, and then were subjected to ligation with the four types of fragments, HGF-X7-d1, HGF-X7-d2, HGF-X7-d3, and HGF-X7-d4, thereby constructing pCA-HGF-X7-d1, pCA-HGF-X7-d2, pCA-HGF-X7-d3, and pCA-HGF-X7-d4, respectively (see FIG. 2).

Test Example 3: Production of AAV-pCA-HGF-X7 derivatives

The respective plasmid DNAs constructed in Test Example 2 were used to produce AAVs. For the production of AAVs, 239T cells (ATCC) were prepared the day before and stabilized for 24 hours. The 293T cells were transfected with the plasmid DNAs constructed in Test Example 2, pHelper as DNA necessary for AAV production, and pAAV-RC (AAV helper-free system, Agilent, USA), and after three days, AAVs were collected. The titers of the collected AAVs were measured using a titration kit (AAVpro Titration Kit, Takara, JP). AAVs were produced using a total of four serotypes (AAV1, AAV2, AAV5, and AAV6).

Test Example 4: Verification of hHGF expression or not of AAV-pCA-HGF-X7 derivatives

4-1. Methods

Out of the AAVs produced in Test Example 3, AAV2-pCA-HGF-X7-d3 and AAV2-pCA-HGF-X7-d4 were tested to investigate hHGF expression. First, C2C12 cells (ATCC) were plated at 8×10^4 cells/well in a 12-well plate, and the cells were stabilized for 24 hours. The C2C12 cells

were respectively infected with equivalent titers of AAV2-pCA-HGF-X7-d3 and AAV2-pCA-HGF-X7-d4. The supernatant was collected two days after infection, and the amount of HGF protein was analyzed by performing HGF ELISA (R&D systems, US).

4-2. Results

As a test result, it was confirmed that both AAV2-pCA-HGF-X7-d3 and AAV2-pCA-HGF-X7-d4 expressed the HGF protein. Especially, it was confirmed that the HGF expression level by AAV2-pCA-HGF-X7-d4 was higher than that by AAV2-pCA-HGF-X7-d3 (see FIG. 3).

Test Example 5: Comparison of hHGF expression between AAV-pCA-HGF-X7-d4 and AAV-pCA-HGF-X8

5-1. Methods

AAV2-pCA-HGF-X7-d4 and AAV2-pCA-HGF-X8 were tested to compare the hHGF expression level as follows. First, C2C12 cells (ATCC) were plated at 8×10^4 cells/well in a 12-well plate, and the cells were stabilized for 24 hours. The C2C12 cells were respectively infected with equivalent titers of AAV2-pCA-HGF-X7-d4 and AAV2-pCA-HGF-X8. The supernatant was collected two days after the infection, and the amount of HGF protein was analyzed by performing HGF ELISA (R&D systems, US).

5-2 Results

As a test result, it was confirmed that both AAV2-pCA-HGF-X7-d4 and AAV2-pCA-HGF-X8 expressed HGF protein, but AAV2-pCA-HGF-X7-d4 showed a significantly higher HGF expression level by about 9-10 times when compared with AAV2-pCA-HGF-X8 (see FIG. 4).

Test Example 6: Effect of intramuscular injection of AAV-pCA-HGF-X7-d4 in ALS mouse models

6-1. Methods

6-1-1. Fabrication of ALS mouse models and gene

delivery

The widely used hSOD1-G93A models were used as ALS models. The models were obtained through crossbreeding of ALS mice (Jackson Laboratory, US), subjected to genotyping, and then examined for the presence or absence of Tg. Ten weeks after birth, the mice were organized into two groups (Tg-AAV6-MCS: 8 animals, Tg-AAV6-pCA-HGF-X7-d4: 7 animals). Non-Tg individuals were sorted out and used as negative control (non-Tg: 5 animals). The mice aged 90 days were administered with AAV at 1×10^{8} GC/site via the thigh muscle, anterior tibial muscle, and gastrocnemius muscle. A total of 3×10^{8} GC/head was administered.

6-1-2. Measurement of disease progression rate, survival rate, and weight

For the evaluation of efficacy, the disease progression rate and the weight were determined, and whether or not the individuals survived was observed. ALS disease eventually causes death according to the progression of the disease, and thus the above three indicators are representative analysis criteria that are widely used in ALS animal tests. The disease progression rate was measured according to the following standards and numerically expressed.

[Symptom score]

5 points: normal

4 points: lower body balance was maintained for 1-2 seconds when mouse tail was grasped.

3 points: lower body balance was maintained for less than 1 second when mouse tail was caught, but walking was normal

2 points: lower body balance was not maintained with legs dragging

1 point: lower body balance was not maintained, walking on tops of feet.

0 points: Death

6-2 Results

It was confirmed that the disease worsened over time in ALS mice (AAV6-MCS administration group). However, it was confirmed that the progression of the disease was delayed by the administration of AAV6-pCA-HGF-X7-d4. When the progression of the disease was numerically expressed, ALS mice had an average symptom score of 2.36 throughout the test period, whereas the group administered with AAV6-pCA-HGF-X7-d4 showed an average symptom score of 2.88, indicating a higher value than that for the ALS mice (AAV6-MCS administration group) (see FIG. 5).

It was also confirmed that the administration of AAV6-pCA-HGF-X7-d4 led to a notable improvement effect in survival rate. With regard thereto, the group administered with AAV6-MCS survived an average of 139 days after birth, whereas the group administered with AAV6-pCA-HGF-X7-d4 survived an average of 147 days, indicating an increase of about 8 days (see FIG. 6).

It was lastly confirmed that ALS mice (AAV6-MCS) had a noticeable increase in weight loss due to muscle loss, but the administration of AAV6-pCA-HGF-X7-d4 slowed weight loss. That is, it was confirmed through a relative comparison of weight that the ALS mice had an average weight change of about 34% from the time of administration to the end of the test, but administration of AAV6-pCA-HGF-X7-d4 showed an average weight change of 22%, indicating slower weight loss (see FIG. 7).

Test Example 7: Effect of intrathecal administration of AAV-pCA-HGF-X7-d4 in ALS mouse models

7-1. Methods

7-1-1. Fabrication of ALS mouse models and gene

delivery

The widely used hSOD1-G93A models were used as ALS models. The models were obtained through crossbreeding of ALS mice (Jackson Laboratory, US), subjected to genotyping, and then examined for the presence or absence of Tg. Individuals retaining a predetermined level of mutant gene were selected and used in the test. Non-Tg individuals were used as a negative control (13 animals). The Tg individuals were organized into a Tg-AAV1-MCS group and a Tg-AAV1-pCA-HGF-X7-d4 group, containing 14 and 16 animals, respectively. At 60 days of age, the mice were intrathecally administered once with AAV at 5×10^{9} GC/site.

7-1-2. Survival rate investigation and behavioral test analysis

For a detailed examination of efficacy, a survival rate, one of the most important indicators in ALS, was investigated, and for the examination of individual motor ability in ALS disease-afflicted individuals, rotarod and hanging-wire tests were carried out. In addition, for the examination of muscular function strength, grip strength was measured.

The survival rate was investigated by checking the survival or death of the individuals every day. As for the rotarod test, an acceleration method was used, in which a mouse was placed on a rotating rod and then the time was measured for how long the mouse spent on the rotating rod, and especially, the speed of the rotating rod was accelerated over time.

As for the hanging-wire test, a mouse was placed on a structure with a lattice pattern, and then the structure was inverted, and the time that the individual spent hanging on to the structure upside down was measured.

As for the grip strength test, the front and back

feet of a mouse were placed on a strength measuring device, and then the muscular strength was measured.

Data are expressed as mean±SEM, and statistical analysis for each data set was performed using one-way ANOVA for each time, followed by Tukey post-hoc test (*: $p<0.05$, **: $p<0.01$, ***: $p<0.001$, ****: $p<0.0001$)

7-2 Results

It was confirmed that a treatment effect was observed in the intrathecal administration of AAV1-pCA-HGF-X7-d4. First, as a result of survival investigation, the AAV1-pCA-HGF-X7-d4 administration group showed a significant survival increase compared with the AAV1-MCS administration group. It was confirmed that the mice had an average lifespan of 144 days when administered with AAV1-MCS, whereas individuals administered with AAV1-pCA-HGF-X7-d4 showed an average lifespan of 160 days, indicating an increase of about 16 days.

Motor ability was observed to be actually enhanced. In the rotarod test, the negative control remained on the rotarod for an average of 226 seconds, whereas the time was significantly decreased to 112 seconds in the Tg-AAV1-MCS group. However, the time was improved to an average of 151 seconds for the test group administered with AAV1-pCA-HGF-X7-d4. Similar treatment effects were also observed in the hanging-wire and grip strength tests. In particular, at the last stage of disease progression (on day 137 after birth), the time spent hanging from the wire was about 31 seconds in the AAV1-pCA-HGF-X7-d4 administration group, indicating a great increase compared with about 7 seconds in the AAV1-MCS administration group. Also in the grip strength measurement results, the AAV1-MCS administration group showed a strength of approximately 28 g, but the strength was significantly increased to 66 g in the pCA-HGF-X7-d4 administration group (see FIG. 8).

Claims

1. An adeno-associated virus (AAV) vector, into which a foreign nucleic acid sequence consisting of: (a) the nucleotide sequence of SEQ ID NO: 5 or (b) a codon-modified nucleotide sequence having sequence homology of at least 80% to SEQ ID NO: 5, wherein said codon-modified nucleotide sequence encodes the same amino acid sequence as the coding region of SEQ ID NO: 5 is introduced.

2. A host cell transformed with the AAV vector of claim 1.

3. A composition comprising (a) the AAV vector of claim 1, and (b) a pharmaceutically acceptable carrier or excipient for use in the prevention or treatment of amyotrophic lateral sclerosis (ALS) or diabetic peripheral neuropathy (DPN).

4. The composition for use of claim 3, wherein the diabetic peripheral neuropathy is polyneuropathy or focal neuropathy.

5. Use of the AAV vector of claim 1 for manufacture of a composition for treating amyotrophic lateral sclerosis (ALS) or diabetic peripheral neuropathy (DPN).

6. The use of claim 5, wherein the diabetic peripheral neuropathy is polyneuropathy or focal neuropathy.

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Fig 1

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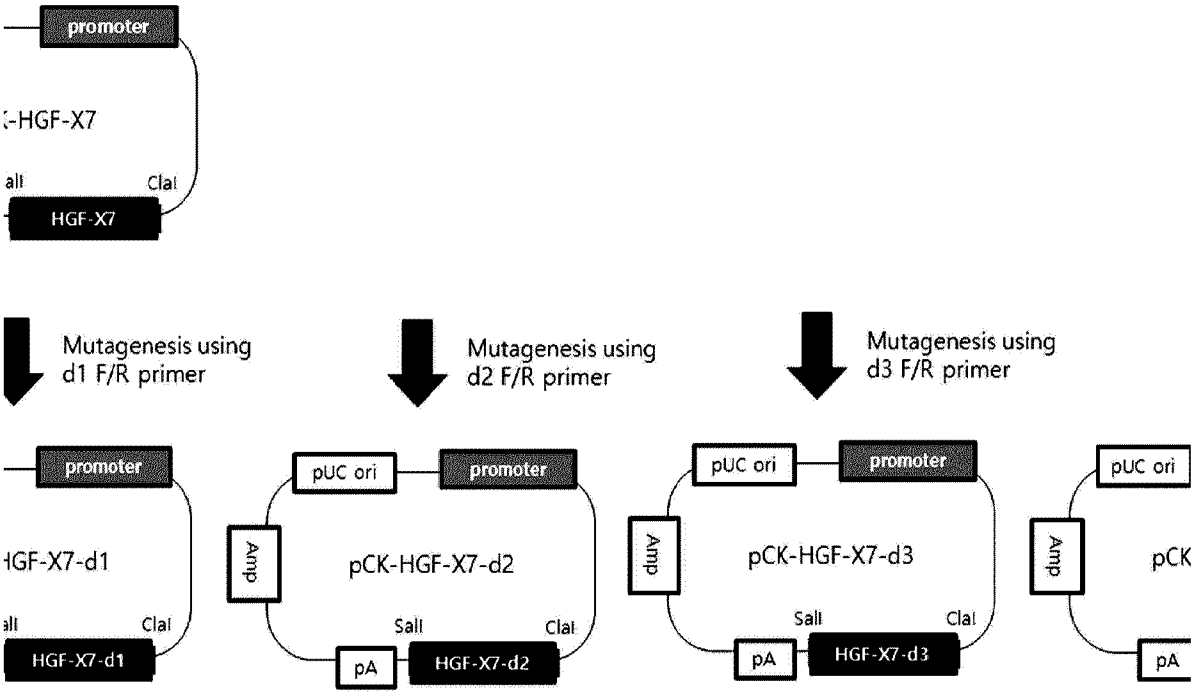

Fig 2

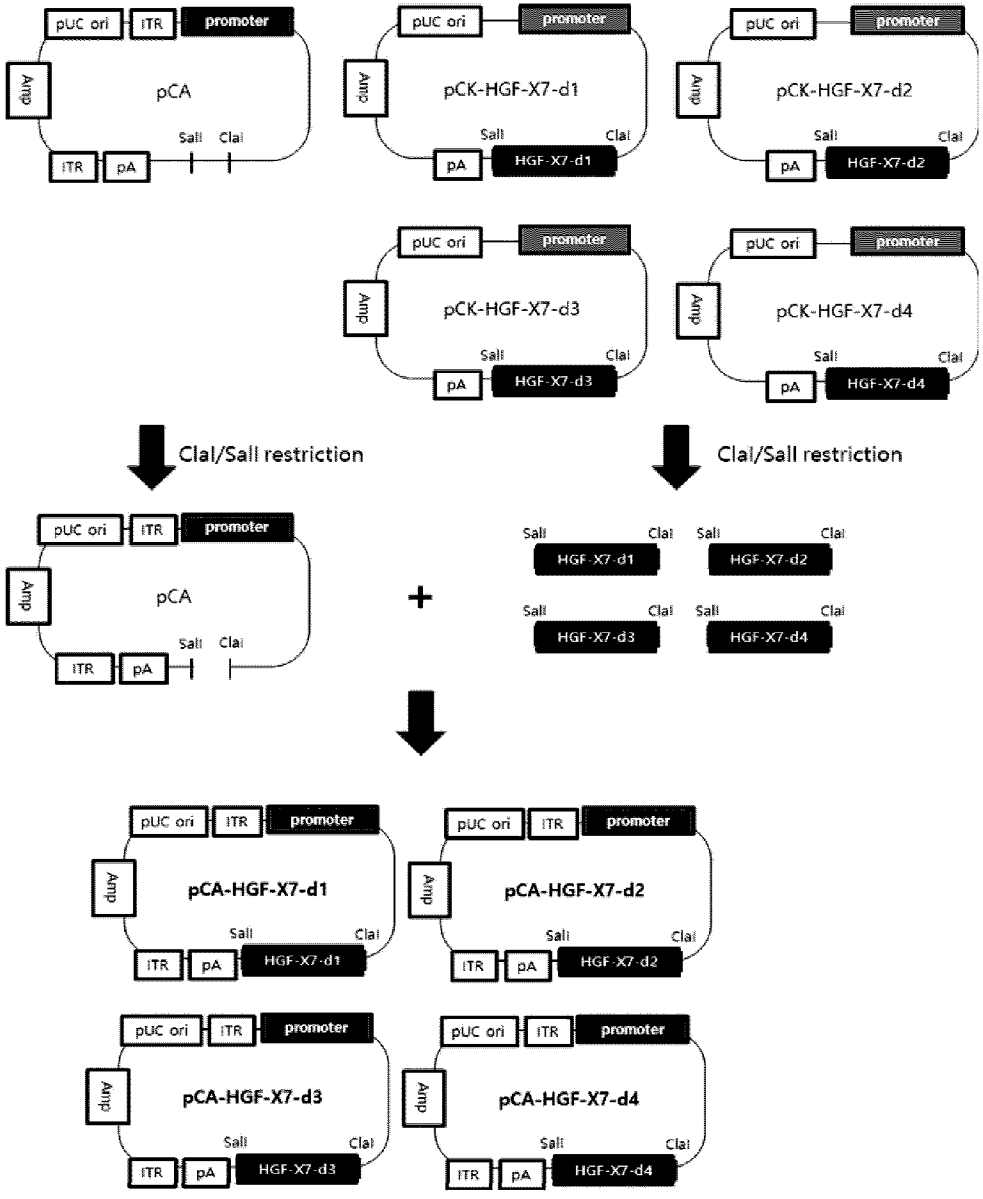

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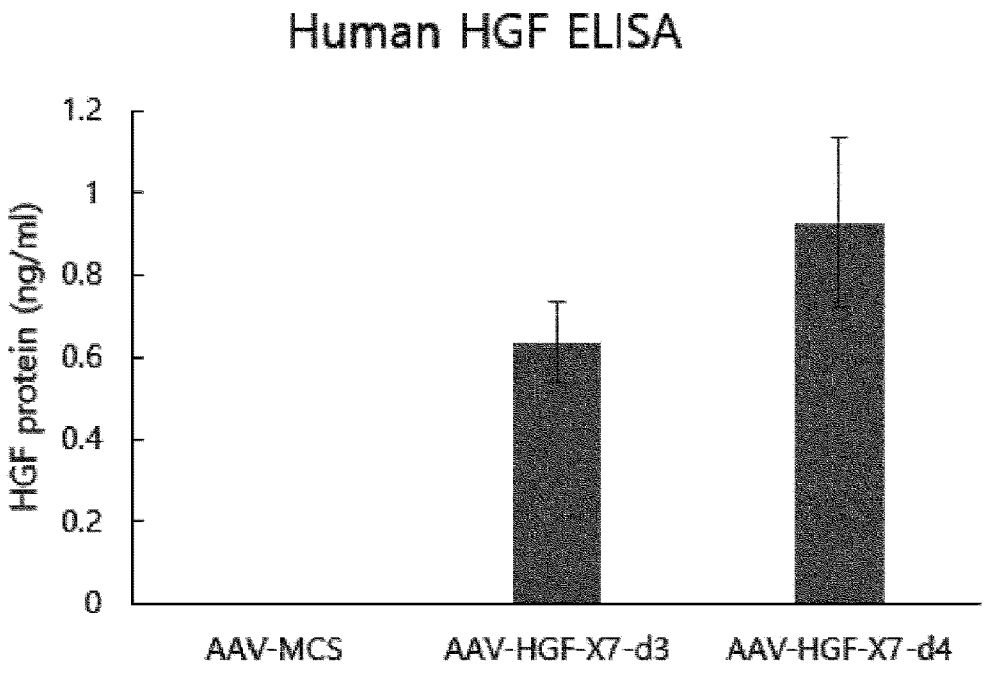
Fig 3



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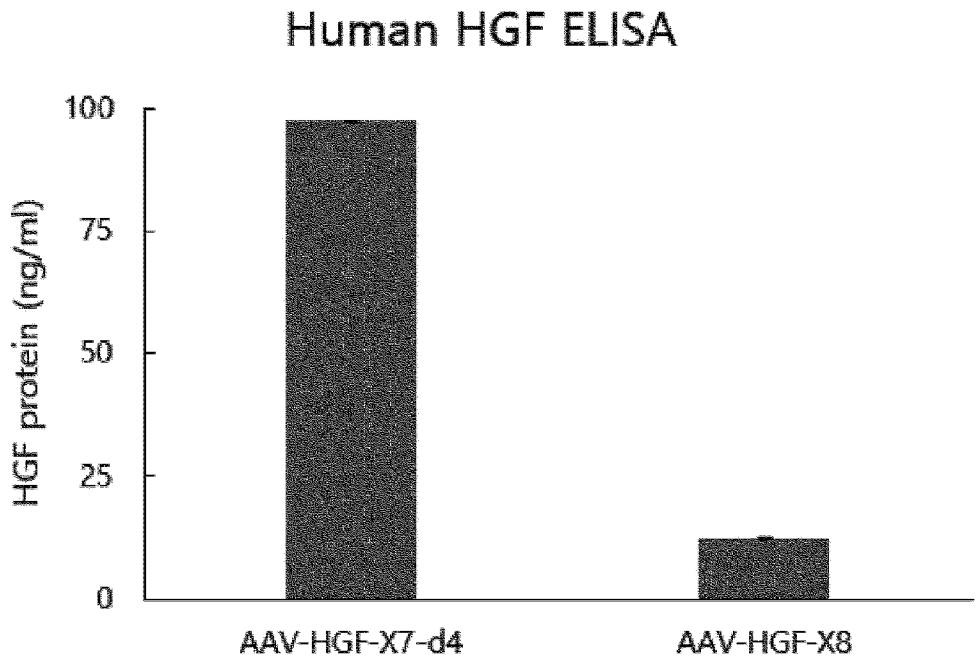
Date reçu/Date received 2020-06-16

Fig 4



CA 03086046 2020-06-16

Date reçu/Date received 2020-06-16

Fig 5

Date reçu/Date received 2020-06-16

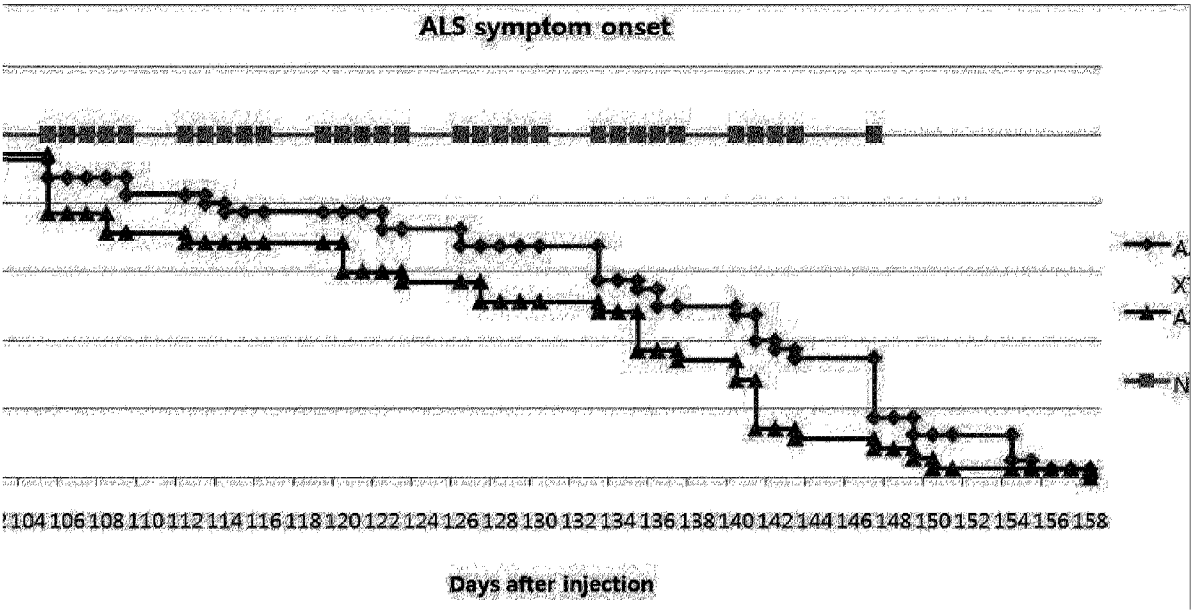


Fig 6

Date reçu/Date received 2020-06-16

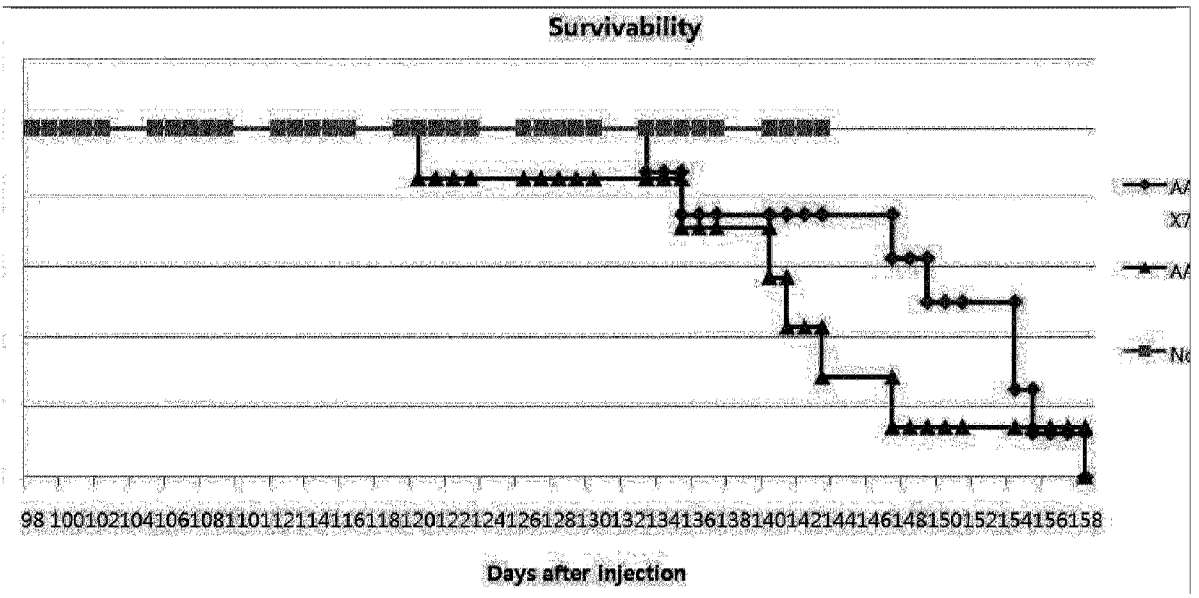
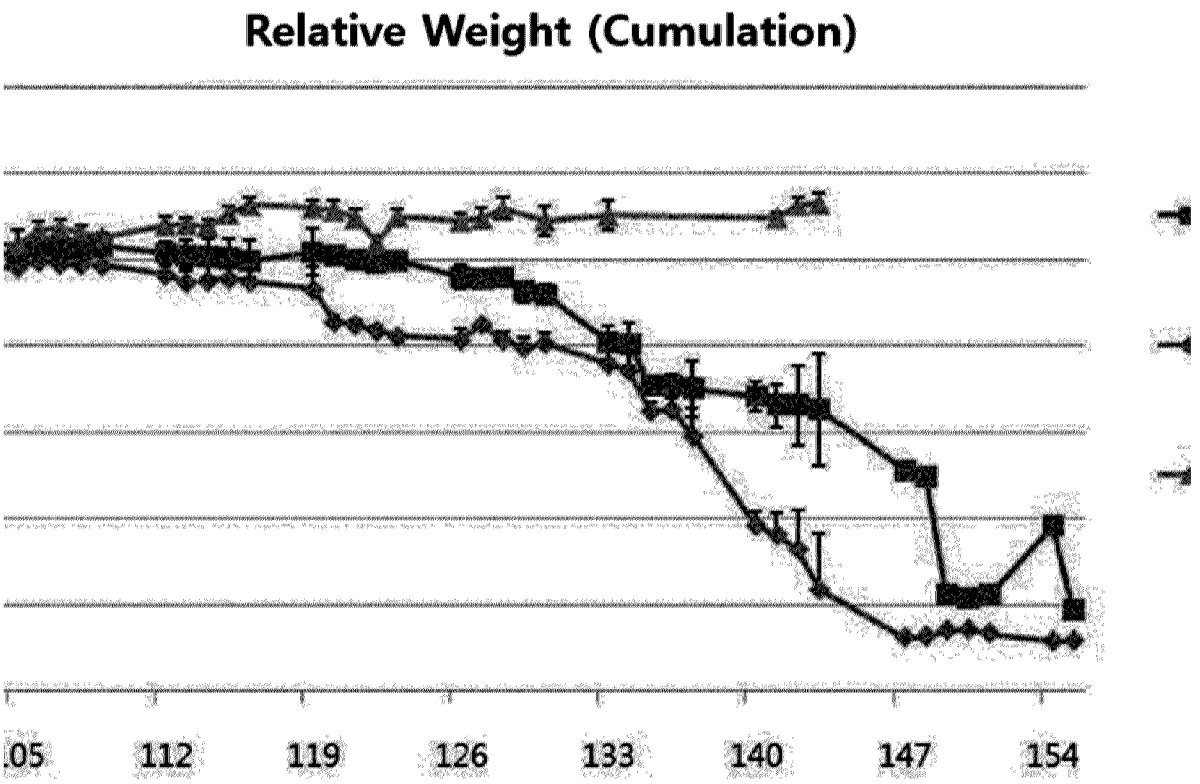


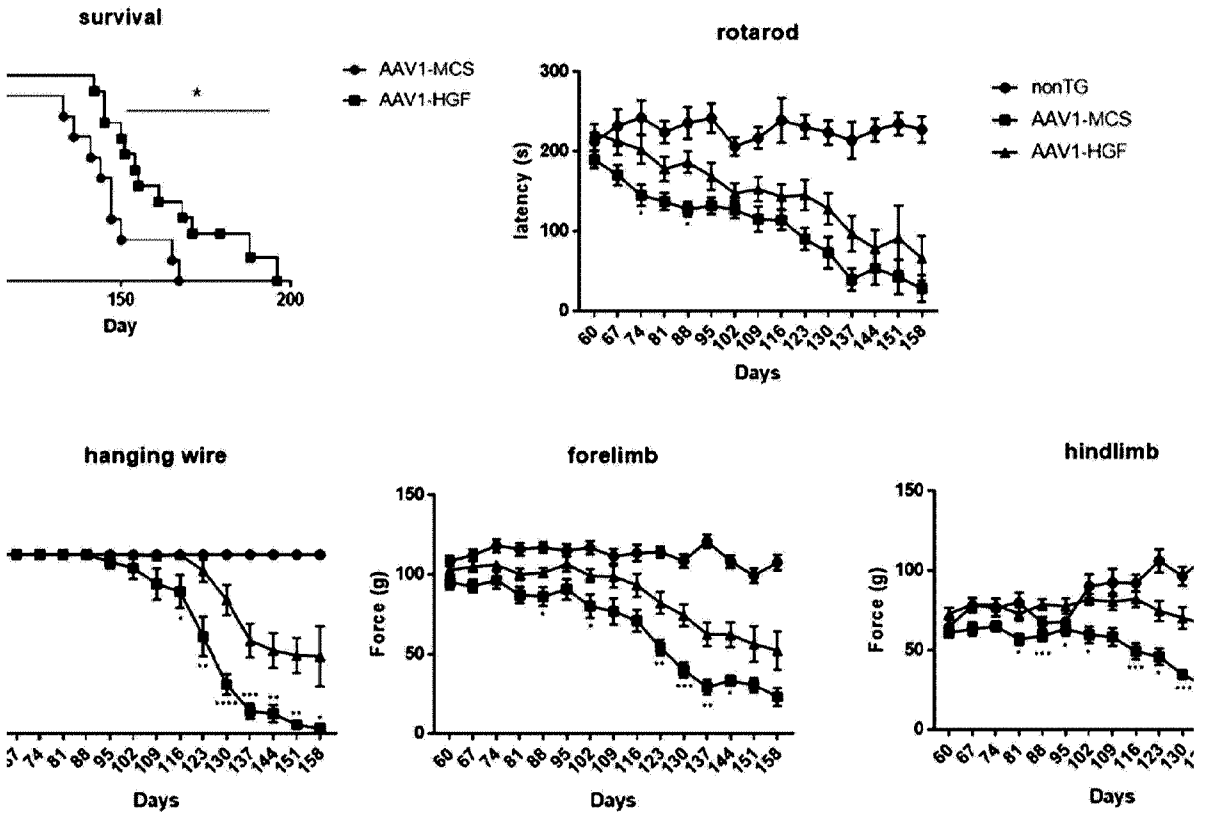
Fig 7

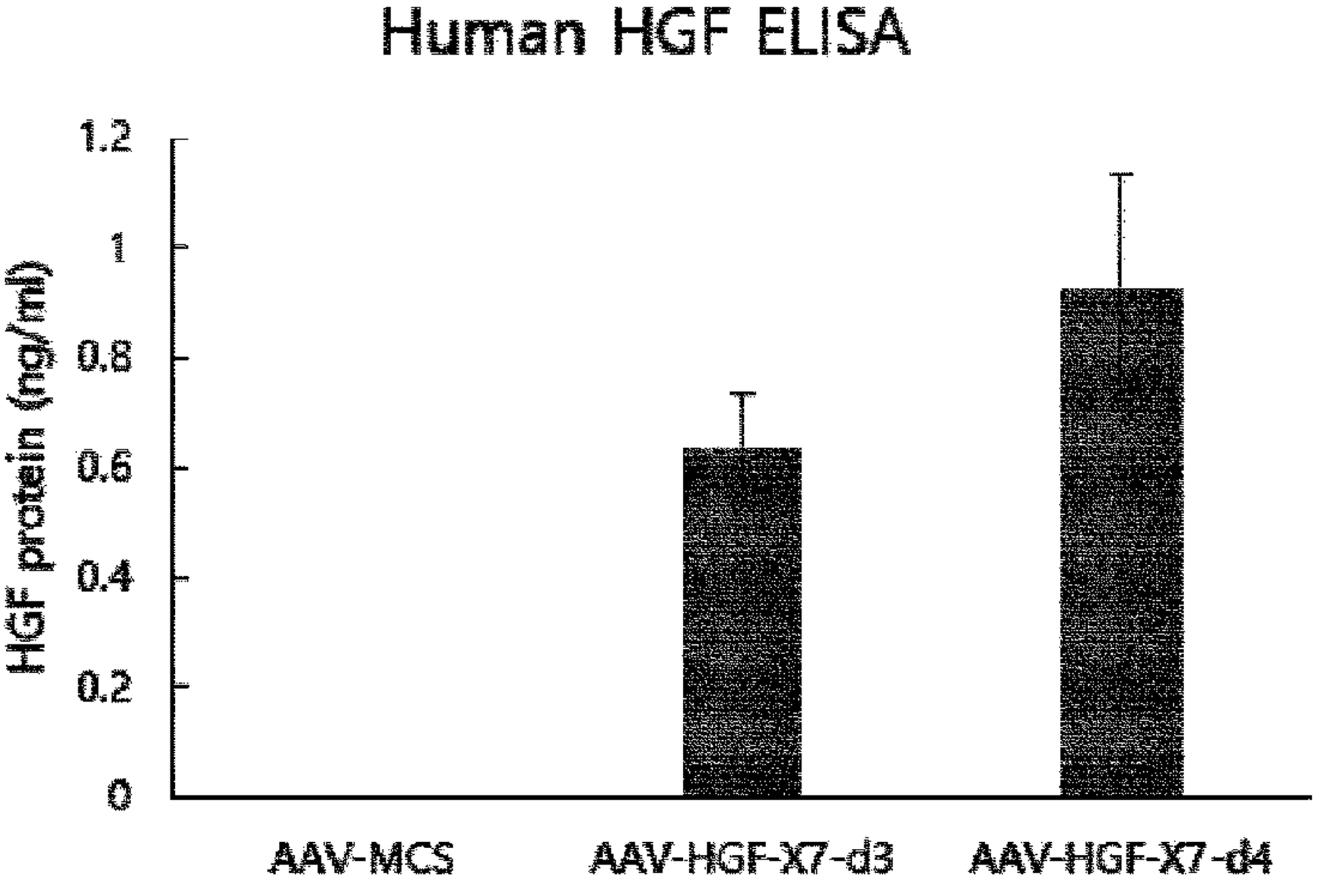
Date reçu/Date received 2020-06-16



Date reçu/Date received 2020-06-16

Fig 8




Human HGF ELISA
HGF protein (ng/ml)
1.2
1
0.8
0.6
0.4
0.2
0
AAV-MCS
AAV-HGF-X7-d3
AAV-HGF-X7-d4