TRPV4 Gene

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Transient receptor potential cation channel subfamily V member 4: The TRPV4 gene provides instructions for making a protein that acts as a calcium channel.

genes

1. Normal Function

The *TRPV4* gene provides instructions for making a protein that acts as a calcium channel. This channel, which transports positively charged atoms of calcium (calcium ions) across cell membranes, is found in many types of cells and tissues. Studies suggest that the TRPV4 channel plays a role in a number of different functions in the body. These include the development of bones and cartilage, the tough but flexible tissue that makes up much of the skeleton during early development. It is also be involved in maintaining the body's water balance (osmoregulation) and in certain types of sensation, particularly the sensation of pain. The TRPV4 channel may also play a role in the self-destruction of cells (apoptosis). It likely has additional functions that have not been identified.

2. Health Conditions Related to Genetic Changes

2.1. Metatropic dysplasia

At least 30 mutations in the *TRPV4* gene have been identified in people with metatropic dysplasia, a skeletal disorder characterized by short stature (dwarfism) with other skeletal abnormalities. Most of these mutations change single protein building blocks (amino acids) in the TRPV4 calcium channel. However, a few mutations insert or delete pieces of DNA in the *TRPV4* gene.

Studies suggest that the *TRPV4* gene mutations that cause metatropic dysplasia overactivate the TRPV4 calcium channel. The resulting increase in calcium in cartilage-forming cells (chondrocytes) may disrupt the early development of cartilage and bone. However, it remains unclear why these mutations affect chondrocytes specifically and how changes in TRPV4 channel activity result in the particular skeletal abnormalities associated with metatropic dysplasia.

2.2. Other disorders

Mutations in the *TRPV4* gene cause a variety of other conditions, most of which affect the developing skeleton or the nervous system.

In addition to metatropic dysplasia, skeletal disorders associated with *TRPV4* gene mutations include autosomal dominant brachyolmia; spondylometaphyseal dysplasia, Kozlowski type; spondyloepiphyseal dysplasia, Maroteaux type; and parastremmatic dysplasia. These related conditions involve combinations of short stature, abnormal side-to-side and back-to-front curvature of the spine (kyphoscoliosis), and other problems with developing bones.

Mutations in the *TRPV4* gene also cause neurological disorders. This spectrum of related conditions includes Charcot-Marie-Tooth disease type 2C, congenital distal spinal muscular atrophy, which is characterized by weakness of muscles in the legs and hips, and scapuloperoneal spinal muscular atrophy, which involves weakness and wasting (atrophy) of muscles in the shoulders and lower legs.

Most of the *TRPV4* gene mutations that cause these skeletal and neurological disorders change single amino acids in the TRPV4 calcium channel. These mutations likely result in an overactive channel, although some research suggests that the mutations may have different effects on channel function in different tissues. Certain *TRPV4* gene mutations have been found to cause skeletal disorders in some people and neurological disorders in others. Additionally, some *TRPV4* gene mutations can cause both skeletal and neurological features in the same individual. Researchers are working to determine how *TRPV4* gene mutations can cause this wide variety of signs and symptoms.

Another bone disorder, known as familial digital arthropathy-brachydactyly, has also been associated with mutations in the *TRPV4* gene. This condition is characterized by arthritis in the joints of the fingers and toes (arthropathy) and shortened fingers and toes (brachydactyly). The mutations that cause this condition appear to impair the function of the TRPV4 calcium channel, preventing it from transporting calcium ions effectively. It is unclear how a loss of channel function leads to the specific features of this condition.

Common variations (polymorphisms) in the *TRPV4* gene have been associated with two additional disorders: hyponatremia, which is a condition of water imbalance that can cause dangerous brain swelling, and chronic obstructive pulmonary disease (COPD), a common lung disease that causes difficulty breathing. It has not been determined how differences in the function of the TRPV4 calcium channel are related to these two conditions.

Because mutations in the *TRPV4* gene are associated with such a wide array of conditions, some researchers have proposed referring to all *TRPV4*-related disorders as *TRPV4*-associated peripheral neuropathy and bony dysplasias (*TRPV4*-PNAB) or *TRPV4*-opathies.

Charcot-Marie-Tooth disease

3. Other Names for This Gene

- osm-9-like TRP channel 4
- OSM9-like transient receptor potential channel 4
- osmosensitive transient receptor potential channel 4

- OTRPC4
- SPSMA
- SSQTL1
- transient receptor potential cation channel, subfamily V, member 4
- transient receptor potential protein 12
- TRP12
- TRPV4_HUMAN
- vanilloid receptor-like channel 2
- vanilloid receptor-related osmotically activated channel
- VR-OAC
- VRL-2
- VRL2
- VROAC

References

1. Andreucci E, Aftimos S, Alcausin M, Haan E, Hunter W, Kannu P, Kerr B,McGillivray G, McKinlay Gardner RJ, Patricelli MG, Sillence D, Thompson E,Zacharin M, Zankl A, Lamandé SR, Savarirayan R. TRPV4 related skeletaldysplasias: a phenotypic spectrum highlighted byclinical, radiographic, andmolecular studies in 21 new families. Orphanet J Rare Dis. 2011 Jun 9;6:37. doi: 10.1186/1750-1172-6-37.
2. Auer-Grumbach M, Olschewski A, Papić L, Kremer H, McEntagart ME, Uhrig S,Fischer C, Fröhlich E, Bálint Z, Tang B, Strohmaier H, Lochmüller H,Schlotter-Weigel B, Senderek J, Krebs A, Dick KJ, Petty R, Longman C, AndersonNE, Padberg GW, Schelhaas HJ, van Ravenswaaij-Arts CM, Pieber TR, Crosby AH,Guelly C. Alterations in the ankyrin domain of TRPV4 cause congenital distal SMA,scapuloperoneal SMA and HMSN2C. Nat Genet. 2010 Feb;42(2):160-4. doi:10.1038/ng.508. Epub 2009 Dec 27.
3. Biasini F, Portaro S, Mazzeo A, Vita G, Fabrizi GM, Taioli F, Toscano A,Rodolico C. TRPV4 related scapuloperoneal spinal muscular atrophy: Report of anItalian family and review of the literature. Neuromuscul Disord. 2016Apr-May;26(4-5):312-5. doi: 10.1016/j.nmd.2016.02.010. Epub 2016 Feb 23. Review.
4. Camacho N, Krakow D, Johnykutty S, Katzman PJ, Pepkowitz S, Vriens J, NiliusB, Boyce BF, Cohn DH. Dominant TRPV4 mutations in nonlethal and lethal metatropicdysplasia. Am J Med Genet A. 2010 May;152A(5):1169-77. doi: 10.1002/ajmg.a.33392.
5. Dai J, Kim OH, Cho TJ, Schmidt-Rimpler M, Tonoki H, Takikawa K, Haga N,Miyoshi K, Kitoh H, Yoo WJ, Choi IH, Song HR, Jin DK, Kim HT, Kamasaki H, BianchiP, Grigelioniene G, Nampoothiri S, Minagawa M, Miyagawa SI, Fukao T, Marcelis C, Jansweijer MC, Hennekam RC, Bedeschi F,

Mustonen A, Jiang Q, Ohashi H, FuruichiT, Unger S, Zabel B, Lausch E, Superti-Furga A, Nishimura G, Ikegawa S. Novel andrecurrent TRPV4 mutations and their association with distinct phenotypes withinthe TRPV4 dysplasia family. J Med Genet. 2010 Oct;47(10):704-9. doi:10.1136/jmg.2009.075358. Epub 2010 Jun 24.

6. Deng HX, Klein CJ, Yan J, Shi Y, Wu Y, Fecto F, Yau HJ, Yang Y, Zhai H,Siddique N, Hedley-Whyte ET, Delong R, Martina M, Dyck PJ, Siddique T.Scapuloperoneal spinal muscular atrophy and CMT2C are allelic disorders caused byalterations in TRPV4. Nat Genet. 2010 Feb;42(2):165-9. doi: 10.1038/ng.509. Epub 2009 Dec 27.
7. Garcia-Elias A, Mrkonjić S, Jung C, Pardo-Pastor C, Vicente R, Valverde MA.The TRPV4 channel. Handb Exp Pharmacol. 2014;222:293-319. doi:10.1007/978-3-642-54215-2_12. Review.
8. Krakow D, Vriens J, Camacho N, Luong P, Deixler H, Funari TL, Bacino CA, IronsMB, Holm IA, Sadler L, Okenfuss EB, Janssens A, Voets T, Rimoin DL, Lachman RS,Nilius B, Cohn DH. Mutations in the gene encoding the calcium-permeable ionchannel TRPV4 produce spondylometaphyseal dysplasia, Kozlowski type andmetatropic dysplasia. Am J Hum Genet. 2009 Mar;84(3):307-15. doi:10.1016/j.ajhg.2009.01.021. Epub 2009 Feb 19.
9. Lamandé SR, Yuan Y, Gresshoff IL, Rowley L, Belluoccio D, Kaluarachchi K,Little CB, Botzenhart E, Zerres K, Amor DJ, Cole WG, Savarirayan R, McIntyre P,Bateman JF. Mutations in TRPV4 cause an inherited arthropathy of hands and feet. Nat Genet. 2011 Oct 2;43(11):1142-6. doi: 10.1038/ng.945.
10. McEntagart M. TRPV4 axonal neuropathy spectrum disorder. J Clin Neurosci. 2012Jul;19(7):927-33. doi: 10.1016/j.jocn.2011.12.003. Epub 2012 May 20. Review.
11. Nishimura G, Lausch E, Savarirayan R, Shiba M, Spranger J, Zabel B, Ikegawa S,Superti-Furga A, Unger S. TRPV4-associated skeletal dysplasias. Am J Med Genet C Semin Med Genet. 2012 Aug 15;160C(3):190-204. doi: 10.1002/ajmg.c.31335. Epub2012 Jul 12. Review.
12. Tian W, Fu Y, Garcia-Elias A, Fernández-Fernández JM, Vicente R, Kramer PL,Klein RF, Hitzemann R, Orwoll ES, Wilmot B, McWeeney S, Valverde MA, Cohen DM. A loss-of-function nonsynonymous polymorphism in the osmoregulatory TRPV4 gene isassociated with human hyponatremia. Proc Natl Acad Sci U S A. 2009 Aug18;106(33):14034-9. doi: 10.1073/pnas.0904084106. Epub 2009 Aug 4.
13. Zhu G; ICGN Investigators, Gulsvik A, Bakke P, Ghatta S, Anderson W, Lomas DA,Silverman EK, Pillai SG. Association of TRPV4 gene polymorphisms with chronicobstructive pulmonary disease. Hum Mol Genet. 2009 Jun 1;18(11):2053-62. doi:10.1093/hmg/ddp111. Epub 2009 Mar 11.
14. Zimoń M, Baets J, Auer-Grumbach M, Berciano J, Garcia A, Lopez-Laso E, MerliniL, Hilton-Jones D, McEntagart M, Crosby AH, Barisic N, Boltshauser E, Shaw CE,Landouré G, Ludlow CL, Gaudet R, Houlden H, Reilly MM, Fischbeck KH, Sumner CJ,Timmerman V, Jordanova A, Jonghe PD. Dominant mutations in the cation channelgene transient receptor potential vanilloid 4 cause

an unusual spectrum ofneuropathies. Brain. 2010 Jun;133(Pt 6):1798-809. doi: 10.1093/brain/awq109. Epub2010 May 11.

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