ACHONDROPLASIA

A 3-in-1 Medical Reference

A Bibliography and Dictionary
for Physicians, Patients,
and Genome Researchers

TO INTERNET REFERENCES

ICON Group International, Inc.

ACHONDROPLASIA

A BIBLIOGRAPHY AND DICTIONARY FOR PHYSICIANS, PATIENTS, AND GENOME RESEARCHERS

JAMES N. PARKER, M.D.
AND PHILIP M. PARKER, PH.D., EDITORS

ICON Health Publications
ICON Group International, Inc.
7404 Trade Street
San Diego, CA 92121 USA

Copyright ©2007 by ICON Group International, Inc.

Copyright ©2007 by ICON Group International, Inc. All rights reserved. This book is protected by copyright. No part of it may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without written permission from the publisher.

Printed in the United States of America.

Last digit indicates print number: 10 9 8 7 6 4 5 3 2 1

Publisher, Health Care: Philip Parker, Ph.D.
Editor(s): James Parker, M.D., Philip Parker, Ph.D.

Publisher's note: The ideas, procedures, and suggestions contained in this book are not intended for the diagnosis or treatment of a health problem. As new medical or scientific information becomes available from academic and clinical research, recommended treatments and drug therapies may undergo changes. The authors, editors, and publisher have attempted to make the information in this book up to date and accurate in accord with accepted standards at the time of publication. The authors, editors, and publisher are not responsible for errors or omissions or for consequences from application of the book, and make no warranty, expressed or implied, in regard to the contents of this book. Any practice described in this book should be applied by the reader in accordance with professional standards of care used in regard to the unique circumstances that may apply in each situation. The reader is advised to always check product information (package inserts) for changes and new information regarding dosage and contraindications before prescribing any drug or pharmacological product. Caution is especially urged when using new or infrequently ordered drugs, herbal remedies, vitamins and supplements, alternative therapies, complementary therapies and medicines, and integrative medical treatments.

Cataloging-in-Publication Data

Parker, James N., 1961-
Parker, Philip M., 1960-

Achondroplasia: A Bibliography and Dictionary for Physicians, Patients, and Genome Researchers/ James N. Parker and Philip M. Parker, editors
p. cm.
Includes bibliographical references, glossary, and index.
ISBN: 0-497-11318-X
1. Achondroplasia-Popular works. I. Title.

Disclaimer

This publication is not intended to be used for the diagnosis or treatment of a health problem. It is sold with the understanding that the publisher, editors, and authors are not engaging in the rendering of medical, psychological, financial, legal, or other professional services.

References to any entity, product, service, or source of information that may be contained in this publication should not be considered an endorsement, either direct or implied, by the publisher, editors, or authors. ICON Group International, Inc., the editors, and the authors are not responsible for the content of any Web pages or publications referenced in this publication.

Copyright Notice

If a physician wishes to copy limited passages from this book for patient use, this right is automatically granted without written permission from ICON Group International, Inc. (ICON Group). However, all of ICON Group publications have copyrights. With exception to the above, copying our publications in whole or in part, for whatever reason, is a violation of copyright laws and can lead to penalties and fines. Should you want to copy tables, graphs, or other materials, please contact us to request permission (E-mail: iconedit@san.rr.com). ICON Group often grants permission for very limited reproduction of our publications for internal use, press releases, and academic research. Such reproduction requires confirmed permission from ICON Group International, Inc. **The disclaimer above must accompany all reproductions, in whole or in part, of this book.**

Acknowledgements

The collective knowledge generated from academic and applied research summarized in various references has been critical in the creation of this book which is best viewed as a comprehensive compilation and collection of information prepared by various official agencies which produce publications on achondroplasia. Books in this series draw from various agencies and institutions associated with the United States Department of Health and Human Services, and in particular, the Office of the Secretary of Health and Human Services (OS), the Administration for Children and Families (ACF), the Administration on Aging (AOA), the Agency for Healthcare Research and Quality (AHRQ), the Agency for Toxic Substances and Disease Registry (ATSDR), the Centers for Disease Control and Prevention (CDC), the Food and Drug Administration (FDA), the Healthcare Financing Administration (HCFA), the Health Resources and Services Administration (HRSA), the Indian Health Service (IHS), the institutions of the National Institutes of Health (NIH), the Program Support Center (PSC), and the Substance Abuse and Mental Health Services Administration (SAMHSA). In addition to these sources, information gathered from the National Library of Medicine, the United States Patent Office, the European Union, and their related organizations has been invaluable in the creation of this book. Some of the work represented was financially supported by the Research and Development Committee at INSEAD. This support is gratefully acknowledged. Finally, special thanks are owed to Tiffany Freeman for her excellent editorial support.

About the Editors

James N. Parker, M.D.

Dr. James N. Parker received his Bachelor of Science degree in Psychobiology from the University of California, Riverside and his M.D. from the University of California, San Diego. In addition to authoring numerous research publications, he has lectured at various academic institutions. Dr. Parker is the medical editor for health books by ICON Health Publications.

Philip M. Parker, Ph.D.

Philip M. Parker is the Chaired Professor of Management Science at INSEAD (Fontainebleau, France and Singapore). Dr. Parker has also been Professor at the University of California, San Diego and has taught courses at Harvard University, the Hong Kong University of Science and Technology, the Massachusetts Institute of Technology, Stanford University, and UCLA. Dr. Parker is the associate editor for ICON Health Publications.

About ICON Health Publications

To discover more about ICON Health Publications, simply check with your preferred online booksellers, including Barnes&Noble.com and Amazon.com which currently carry all of our titles. Or, feel free to contact us directly for bulk purchases or institutional discounts:

ICON Group International, Inc.
7404 Trade Street
San Diego, CA 92121 USA
Fax: 858-635-9414
Web site: **www.icongrouponline.com/health**

Table of Contents

FORWARD

In March 2001, the National Institutes of Health issued the following warning: "The number of Web sites offering health-related resources grows every day. Many sites provide valuable information, while others may have information that is unreliable or misleading."[1] Furthermore, because of the rapid increase in Internet-based information, many hours can be wasted searching, selecting, and printing. Since only the smallest fraction of information dealing with achondroplasia is indexed in search engines, such as **www.google.com** or others, a non-systematic approach to Internet research can be not only time consuming, but also incomplete. This book was created for medical professionals, students, and members of the general public who want to know as much as possible about achondroplasia, using the most advanced research tools available and spending the least amount of time doing so.

In addition to offering a structured and comprehensive bibliography, the pages that follow will tell you where and how to find reliable information covering virtually all topics related to achondroplasia, from the essentials to the most advanced areas of research. Special attention has been paid to present the genetic basis and pattern of inheritance of achondroplasia. Public, academic, government, and peer-reviewed research studies are emphasized. Various abstracts are reproduced to give you some of the latest official information available to date on achondroplasia. Abundant guidance is given on how to obtain free-of-charge primary research results via the Internet. **While this book focuses on the field of medicine, when some sources provide access to non-medical information relating to achondroplasia, these are noted in the text.**

E-book and electronic versions of this book are fully interactive with each of the Internet sites mentioned (clicking on a hyperlink automatically opens your browser to the site indicated). If you are using the hard copy version of this book, you can access a cited Web site by typing the provided Web address directly into your Internet browser. You may find it useful to refer to synonyms or related terms when accessing these Internet databases. **NOTE:** At the time of publication, the Web addresses were functional. However, some links may fail due to URL address changes, which is a common occurrence on the Internet.

For readers unfamiliar with the Internet, detailed instructions are offered on how to access electronic resources. For readers unfamiliar with medical terminology, a comprehensive glossary is provided. We hope these resources will prove useful to the widest possible audience seeking information on achondroplasia.

The Editors

[1] From the NIH, National Cancer Institute (NCI): **http://www.cancer.gov/**.

CHAPTER 1. STUDIES ON ACHONDROPLASIA

Overview

In this chapter, we will show you how to locate peer-reviewed references and studies on achondroplasia. For those interested in basic information about achondroplasia, we begin with a condition summary published by the National Library of Medicine.

Genetics Home Reference

Genetics Home Reference (GHR) is the National Library of Medicine's Web site for consumer information about genetic conditions and the genes or chromosomes responsible for those conditions. Here you can find a condition summary on achondroplasia that describes the major features of the condition, provides information about the condition's genetic basis, and explains its pattern of inheritance. In addition, a summary of the gene or chromosome related to achondroplasia is provided. [2]

The Genetics Home Reference has recently published the following summary for achondroplasia:

What Is Achondroplasia?[3]

Achondroplasia is a disorder of bone growth. Although achondroplasia literally means "without cartilage formation," the problem is not in forming cartilage but in converting it to bone, particularly in the long bones of the arms and legs.

All people with achondroplasia have short stature. The average height of an adult male with achondroplasia is 131 centimeters (4 feet, 4 inches), and the average height for adult females is 124 centimeters (4 feet, 1 inch). Characteristic features of achondroplasia include an average-size trunk, short arms and legs with particularly short upper arms and thighs,

---

[2] This section has been adapted from the National Library of Medicine: **http://ghr.nlm.nih.gov/**.

[3] Adapted from the Genetics Home Reference of the National Library of Medicine: **http://ghr.nlm.nih.gov/condition=achondroplasia**.

limited range of motion at the elbows, and an enlarged head (macrocephaly) with a prominent forehead. Fingers are typically short and the ring finger and middle finger may diverge, giving the hand a three-pronged (trident) appearance. People with achondroplasia are generally of normal intelligence.

Health problems commonly associated with achondroplasia include episodes in which breathing slows or stops for short periods (apnea), obesity, and recurrent ear infections. In adulthood, individuals with the condition usually develop a pronounced and permanent sway of the lower back (lordosis) and bowed legs. Older individuals often have back pain, which can cause difficulty with walking.

How Common Is Achondroplasia?

Achondroplasia is the most common type of short-limbed dwarfism. The condition occurs in 1 in 15,000 to 40,000 newborns.

What Genes Are Related to Achondroplasia?

Mutations in the **FGFR3** (**http://ghr.nlm.nih.gov/gene=fgfr3**) gene cause achondroplasia.

The FGFR3 gene provides instructions for making a protein that is involved in the development and maintenance of bone and brain tissue. This protein limits the formation of bone from cartilage (a process called ossification), particularly in the long bones. Two specific mutations in the FGFR3 gene are responsible for almost all cases of achondroplasia. Researchers believe that these mutations cause the protein to be overly active, which interferes with skeletal development and leads to the disturbances in bone growth seen with this disorder.

How Do People Inherit Achondroplasia?

Achondroplasia is inherited in an autosomal dominant pattern, which means one copy of the altered gene in each cell is sufficient to cause the disorder. About 80 percent of people with achondroplasia have average-size parents; these cases result from a new mutation in the FGFR3 gene. In the remaining cases, people with achondroplasia have inherited an altered FGFR3 gene from one or two affected parents. Individuals who inherit two altered copies of this gene typically have very severe problems with bone growth, and are usually stillborn or die shortly after birth from respiratory failure.

Where Can I Find Additional Information about Achondroplasia?

You may find the following resources about achondroplasia helpful. These materials are written for the general public.

NIH Publications - National Institutes of Health

- **http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=gnd.section.256**

MedlinePlus - Health Information

- Encyclopedia: Achondroplasia:
  http://www.nlm.nih.gov/medlineplus/ency/article/001577.htm
- Encyclopedia: Lordosis:
  http://www.nlm.nih.gov/medlineplus/ency/article/003278.htm
- Health Topic: Dwarfism:
  http://www.nlm.nih.gov/medlineplus/dwarfism.html

Educational Resources - Information Pages

- Ask the Geneticist: Inheritance of achondroplasia:
  http://www.askthegen.org/question.php?question_id=692
- Centre for Genetics Education:
  http://www.genetics.com.au/factsheet/43.htm
- Children's Hospital Boston:
  http://www.childrenshospital.org/az/Site558/mainpageS558P0.html
- Department of Orthopaedic Surgery, Johns Hopkins University:
  http://www.hopkinsmedicine.org/orthopedicsurgery/achondroplasia.html
- Greenberg Center for Skeletal Dysplasias:
  http://www.hopkinsmedicine.org/greenbergcenter/achon.htm
- Madisons Foundation:
  http://www.madisonsfoundation.org/content/3/1/display.asp?did=260
- Nemours:
  http://www.nemours.org/internet?url=no/dysplasia/achondroplasia.html
- Orphanet:
  http://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=GB&Expert=15
- The Wellcome Trust:
  http://genome.wellcome.ac.uk/doc_WTD020861.html
- University of Virginia Health System:
  http://www.healthsystem.virginia.edu/UVAHealth/peds_diabetes/achondro.cfm

Patient Support - for Patients and Families

- Human Growth Foundation:
  http://www.hgfound.org
- International Skeletal Dysplasia Registry, Cedars-Sinai Medical Center:
  http://www.csmc.edu/3805.html
- Little People of America, Inc.:
  http://www.lpaonline.org

- March of Dimes:
  http://www.marchofdimes.com/pnhec/4439_1204.asp
- National Organization for Rare Disorders:
  http://www.rarediseases.org/search/rdbdetail_abstract.html?disname=Achondroplasia
- Resource list from the University of Kansas Medical Center:
  http://www.kumc.edu/gec/support/dwarfism.html
- The MAGIC Foundation:
  http://www.magicfoundation.org/

Professional Resources

You may also be interested in these resources, which are designed for healthcare professionals and researchers.

- Gene Reviews - Clinical summary:
  http://www.genetests.org/query?dz=achondroplasia
- Gene Tests - DNA tests ordered by healthcare professionals:
  http://www.genetests.org/query?testid=2789
- ClinicalTrials.gov - Linking patients to medical research:
  http://clinicaltrials.gov/search/condition=%22achondroplasia%22?recruiting=false
- PubMed - Recent literature:
  http://ghr.nlm.nih.gov/condition=achondroplasia/show/PubMed;jsessionid=EE42AE95D313DDE2504E562C955E927E
- OMIM - Genetic disorder catalog:
  http://www.ncbi.nlm.nih.gov/entrez/dispomim.cgi?id=100800

References

These sources were used to develop the Genetics Home Reference condition summary on achondroplasia.

- Gene Review
- Greenberg Center for Skeletal Dysplasias
- Horton WA, Lunstrum GP. Fibroblast growth factor receptor 3 mutations in achondroplasia and related forms of dwarfism. Rev Endocr Metab Disord. 2002 Dec;3(4):381-5. Review. No abstract available. PubMed citation
- Horton WA. Recent milestones in achondroplasia research. Am J Med Genet A. 2006 Jan 15;140(2):166-9. No abstract available. PubMed citation
- Scriver, Charles R; The metabolic & molecular bases of inherited disease; 8th ed.; New York : McGraw-Hill, c2001. p5379-5395. NLM Catalog
- Vajo Z, Francomano CA, Wilkin DJ. The molecular and genetic basis of fibroblast growth factor receptor 3 disorders: the achondroplasia family of skeletal dysplasias, Muenke craniosynostosis, and Crouzon syndrome with acanthosis nigricans. Endocr Rev. 2000 Feb;21(1):23-39. Review. PubMed citation

A summary of the gene related to achondroplasia is provided below:

What Is the Official Name of the FGFR3 Gene?[4]

The official name of this gene is "fibroblast growth factor receptor 3 (achondroplasia, thanatophoric dwarfism)."

FGFR3 is the gene's official symbol. The FGFR3 gene is also known by other names, listed below.

What Is the Normal Function of the FGFR3 Gene?

The FGFR3 gene provides instructions for making a protein called fibroblast growth factor receptor 3. This protein is part of a family of fibroblast growth factor receptors that share similar structures and functions. These proteins play a role in several important cellular processes, including regulation of cell growth and division, determination of cell type, formation of blood vessels, wound healing, and embryo development.

The FGFR3 protein spans the cell membrane, so that one end of the protein remains inside the cell and the other end projects from the outer surface of the cell. This positioning of the protein allows it to interact with specific growth factors outside the cell and to receive signals that control growth and development. When these growth factors attach to the FGFR3 protein, the protein triggers a cascade of chemical reactions inside the cell that instructs the cell to undergo certain changes, such as maturing to take on specialized functions.

The FGFR3 protein is involved in the development and maintenance of bone and brain tissue. Researchers believe that this receptor regulates bone growth by limiting the formation of bone from cartilage (a process called ossification), particularly in the long bones.

[4] Adapted from the Genetics Home Reference of the National Library of Medicine: **http://ghr.nlm.nih.gov/gene=fgfr3;jsessionid=EE42AE95D313DDE2504E562C955E927E**.

What Conditions Are Related to the FGFR3 Gene?

Achondroplasia - Caused by Mutations in the FGFR3 Gene

Two mutations in the FGFR3 gene cause more than 99 percent of cases of achondroplasia. Both mutations lead to the same change in building blocks (amino acids) that make up the fibroblast growth factor receptor 3 protein. Specifically, the amino acid glycine is replaced with the amino acid arginine at protein position 380 (written as Gly380Arg or G380R). Researchers believe that this genetic change causes the receptor to be overly active, which leads to the disturbances in bone growth seen with this disorder.

Crouzonodermoskeletal Syndrome - Caused by Mutations in the FGFR3 Gene

Two mutations in the FGFR3 gene cause more than 99 percent of cases of achondroplasia. Both mutations lead to the same change in building blocks (amino acids) that make up the fibroblast growth factor receptor 3 protein. Specifically, the amino acid glycine is replaced with the amino acid arginine at protein position 380 (written as Gly380Arg or G380R). Researchers believe that this genetic change causes the receptor to be overly active, which leads to the disturbances in bone growth seen with this disorder.

Hypochondroplasia - Caused by Mutations in the FGFR3 Gene

A single FGFR3 mutation has been identified in people with Crouzonodermoskeletal syndrome. This genetic change replaces the amino acid alanine with the amino acid glutamic acid at position 391 of the fibroblast growth factor receptor 3 protein (written as Ala391Glu or A391E). Researchers have not determined how this mutation leads to the signs and symptoms of this disorder, but the altered receptor appears to disrupt the normal growth of skull bones and affect skin pigmentation.

Muenke Syndrome - Caused by Mutations in the FGFR3 Gene

Several mutations in the FGFR3 gene have been identified in people with hypochondroplasia. Many cases are caused by one of two specific FGFR3 mutations, both of which lead to the same change in amino acids in the fibroblast growth factor receptor 3 protein. Specifically, the amino acid asparagine is replaced with the amino acid lysine at protein position 540 (written as Asn540Lys or N540K). Other FGFR3 mutations probably cause a small number of cases of hypochondroplasia. Although the effects of these mutations have not been explained, they probably cause the receptor to be mildly overactivated, which leads to the disturbances in bone growth seen with this disorder.

SADDAN - Caused by Mutations in the FGFR3 Gene

A single mutation in the FGFR3 gene has been shown to cause Muenke syndrome. This change substitutes the amino acid arginine for the amino acid proline at position 250 in the fibroblast growth factor receptor 3 protein (written as Pro250Arg or P250R). This mutation

results in the production of a receptor that is overly active, which allows the bones of the skull to fuse before they should.

Thanatophoric Dysplasia - Caused by Mutations in the FGFR3 Gene

One mutation in the FGFR3 gene has been identified in people with SADDAN (severe achondroplasia with developmental delay and acanthosis nigricans). This genetic change substitutes the amino acid methionine for the amino acid lysine at position 650 of the fibroblast growth factor receptor 3 protein (written as Lys650Met or K650M). Researchers believe that this mutation strongly overactivates the FGFR3 protein, which leads to severe problems with bone growth. It remains uncertain how the mutation disrupts brain development or causes acanthosis nigricans (a skin disorder characterized by thick, dark, velvety skin).

Bladder Cancer - Associated with the FGFR3 Gene

At least 10 mutations in the FGFR3 gene have been identified in people with thanatophoric dysplasia type I. Most of these mutations change a single amino acid in the fibroblast growth factor receptor 3 protein. The most common mutation substitutes the amino acid cysteine for the amino acid arginine at protein position 248 (written as Arg248Cys or R248C). Other mutations cause the protein to be longer than normal.

Other Disorders - Caused by Mutations in the FGFR3 Gene

Some gene mutations are acquired during a person's lifetime and are present only in certain cells. These changes, which are called somatic mutations, are not inherited. Somatic mutations in the FGFR3 gene are associated with some cases of bladder cancer. These mutations overactivate the fibroblast growth factor receptor 3 protein, which likely directs bladder cells to grow and divide in the absence of signals from outside the cell. This uncontrolled cell division leads to the formation of a bladder tumor.

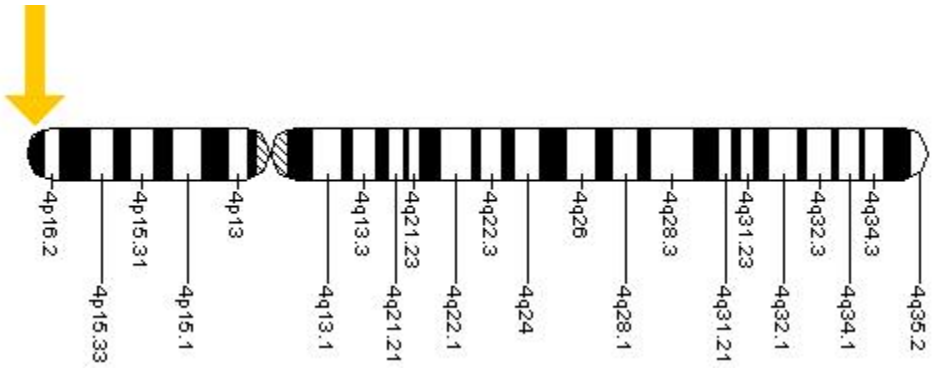
Other Cancers - Associated with the FGFR3 Gene

Mutations in the FGFR3 gene also cause platyspondylic lethal skeletal dysplasia, San Diego type. This skeletal disorder is characterized by severe problems with bone growth similar to thanatophoric dysplasia. Most mutations that cause this disorder change single amino acids in the FGFR3 protein. The altered protein is improperly folded and cannot be transported to the cell membrane. Instead, it accumulates within cartilage cells (chondrocytes) and forms clumps called inclusion bodies. The absence of normal FGFR3 signaling and the formation of inclusion bodies probably disrupt the normal development of bones, leading to the skeletal abnormalities characteristic of platyspondylic lethal skeletal dysplasia, San Diego type.

Where Is the FGFR3 Gene Located?

Cytogenetic Location: 4p16.3

Molecular Location on chromosome 4: base pairs 1,765,420 to 1,780,395



The FGFR3 gene is located on the short (p) arm of chromosome 4 at position 16.3.

More precisely, the FGFR3 gene is located from base pair 1,765,420 to base pair 1,780,395 on chromosome 4.

References

These sources were used to develop the Genetics Home Reference gene summary on the FGFR3 gene.

- Brodie SG, Kitoh H, Lachman RS, Nolasco LM, Mekikian PB, Wilcox WR. Platyspondylic lethal skeletal dysplasia, San Diego type, is caused by FGFR3 mutations. Am J Med Genet. 1999 Jun 11;84(5):476-80. PubMed citation
- Cappellen D, De Oliveira C, Ricol D, de Medina S, Bourdin J, Sastre-Garau X, Chopin D, Thiery JP, Radvanyi F. Frequent activating mutations of FGFR3 in human bladder and cervix carcinomas. Nat Genet. 1999 Sep;23(1):18-20. No abstract available. PubMed citation
- Chen L, Deng CX. Roles of FGF signaling in skeletal development and human genetic diseases. Front Biosci. 2005 May 1;10:1961-76. PubMed citation
- Cohen MM Jr. Some chondrodysplasias with short limbs: molecular perspectives. Am J Med Genet. 2002 Oct 15;112(3):304-13. Review. PubMed citation
- Coumoul X, Deng CX. Roles of FGF receptors in mammalian development and congenital diseases. Birth Defects Res C Embryo Today. 2003 Nov;69(4):286-304. Review. PubMed citation
- Eswarakumar VP, Lax I, Schlessinger J. Cellular signaling by fibroblast growth factor receptors. Cytokine Growth Factor Rev. 2005 Apr;16(2):139-49. Epub 2005 Feb 1. PubMed citation
- Horton WA, Lunstrum GP. Fibroblast growth factor receptor 3 mutations in achondroplasia and related forms of dwarfism. Rev Endocr Metab Disord. 2002 Dec;3(4):381-5. Review. No abstract available. PubMed citation
- Kimura T, Suzuki H, Ohashi T, Asano K, Kiyota H, Eto Y. The incidence of thanatophoric dysplasia mutations in FGFR3 gene is higher in low-grade or superficial

bladder carcinomas. Cancer. 2001 Nov 15;92(10):2555-61. Erratum in: Cancer 2002 Apr 1;94(7):2117. PubMed citation

- L'Hote CG, Knowles MA. Cell responses to FGFR3 signalling: growth, differentiation and apoptosis. Exp Cell Res. 2005 Apr 1;304(2):417-31. Epub 2004 Dec 16. Review. PubMed citation
- Lievens PM, Liboi E. The thanatophoric dysplasia type II mutation hampers complete maturation of fibroblast growth factor receptor 3 (FGFR3), which activates signal transducer and activator of transcription 1 (STAT1) from the endoplasmic reticulum. J Biol Chem. 2003 May 9;278(19):17344-9. Epub 2003 Mar 06. PubMed citation
- Vajo Z, Francomano CA, Wilkin DJ. The molecular and genetic basis of fibroblast growth factor receptor 3 disorders: the achondroplasia family of skeletal dysplasias, Muenke craniosynostosis, and Crouzon syndrome with acanthosis nigricans. Endocr Rev. 2000 Feb;21(1):23-39. Review. PubMed citation
- van Rhijn BW, van Tilborg AA, Lurkin I, Bonaventure J, de Vries A, Thiery JP, van der Kwast TH, Zwarthoff EC, Radvanyi F. Novel fibroblast growth factor receptor 3 (FGFR3) mutations in bladder cancer previously identified in non-lethal skeletal disorders. Eur J Hum Genet. 2002 Dec;10(12):819-24. PubMed citation
- Wilkie AO. Bad bones, absent smell, selfish testes: the pleiotropic consequences of human FGF receptor mutations. Cytokine Growth Factor Rev. 2005 Apr;16(2):187-203. Epub 2005 Apr 1. PubMed citation
- Zieger K, Dyrskjot L, Wiuf C, Jensen JL, Andersen CL, Jensen KM, Orntoft TF. Role of activating fibroblast growth factor receptor 3 mutations in the development of bladder tumors. Clin Cancer Res. 2005 Nov 1;11(21):7709-19. PubMed citation

Federally Funded Research on Achondroplasia

The U.S. Government supports a variety of research studies relating to achondroplasia. These studies are tracked by the Office of Extramural Research at the National Institutes of Health.[5]

CRISP (Computerized Retrieval of Information on Scientific Projects)

CRISP is a searchable database of federally funded biomedical research projects conducted at universities, hospitals, and other institutions. Search the CRISP Web site at **http://crisp.cit.nih.gov/crisp/crisp_query.generate_screen**. You will have the option to perform targeted searches by various criteria, including geography, date, and topics related to achondroplasia.

For most of the studies, the agencies reporting into CRISP provide summaries or abstracts. As opposed to clinical trial research using patients, many federally funded studies use animals or simulated models to explore achondroplasia. The following is typical of the type of information found when searching the CRISP database for achondroplasia:

[5] Healthcare projects are funded by the National Institutes of Health (NIH), Substance Abuse and Mental Health Services (SAMHSA), Health Resources and Services Administration (HRSA), Food and Drug Administration (FDA), Centers for Disease Control and Prevention (CDCP), Agency for Healthcare Research and Quality (AHRQ), and Office of Assistant Secretary of Health (OASH).