What is Hypochondroplasia?

Restricted Growth Association

Working to benefit people with restricted growth and their families

This booklet has been written to provide information and support for parents of children with hypochondroplasia, people with the condition, their families, friends, teachers and health care professionals.

Dr Will Christian is a paediatrician who has achondroplasia (restricted growth).

RGA acknowledges the help of the many members and their families who have contributed their experiences towards this booklet. Their contributions were compiled by RGA Information Officer, Ros Smith.

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The contents of this booklet are believed to be correct at the time of publication. However, knowledge about hypochondroplasia is growing all the time, especially in the areas of genetics and orthopaedics. We encourage you to find out about new developments from the RGA and other sources, some of which are listed at the end of this booklet.

What is Hypochondroplasia?

by Will Christian MBBS, BSc

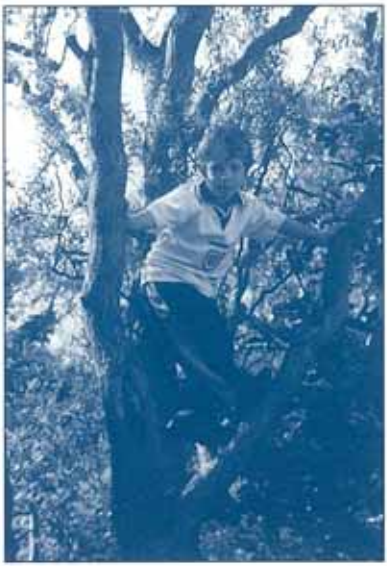
'When your child is suspected of having hypochondroplasia, you think of them always being short, never growing as tall as you or their peers. But as our child became older, we realised that he could do all the same things as other children and, with our love and support, he would have just the same chances in life.'

Hypochondroplasia is a rare condition and is one of the types of restricted growth with disproportionate stature (in this case this term refers to people with an average size body but shorter limbs). As with many causes of short stature, hypochondroplasia is mainly a physical condition – people with the condition have a normal range of intelligence and occupy positions in all sectors of society.

Hypochondroplasia is a condition that covers a wide range of heights and abilities. Most people with hypochondroplasia live normal, happy lives, although for some there may be a few physical limitations.

Many practical difficulties can be overcome with a little imagination. Clothes can be altered, cars/bicycles can be adapted (for more information, see the RGA **Lifestyles** series), and there is no reason why someone with hypochondroplasia should not participate in most activities. All children (and adults!), including those with hypochondroplasia, will find their own limits and boundaries, and it is important that, within reason, these are not imposed upon them by others or by society.

'One of the most helpful things for us, when we learned that Jack had hypochondroplasia, was to be told that he could lead a normal life. It was also very important to be put in contact with another child who had the same condition.'



What does hypochondroplasia mean?

Hypochondroplasia literally means 'low cartilage growth'. It is a genetic condition, beginning at conception and continuing throughout life. The effects may not be very obvious at birth and a diagnosis is sometimes not made until a child is of school age. Rarely, it goes undetected until later in life.

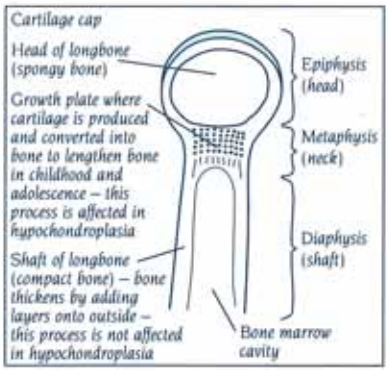
'It wasn't until my son appeared to stop growing when he was seven that he was diagnosed with hypochondroplasia. Then they realised that he had inherited it from me and I had inherited it from my father who we had always thought of as rather short, but for no particular reason.'

In the growing baby and child, bone forms from cartilage. Cartilage is produced at the ends of the long bones in an area called the *growth plate**. In people with hypochondroplasia, the growth plate works more slowly than normal. This means that only a small amount of cartilage is produced in the arms and legs for conversion into bone. The result is short limbs. The tissues (muscle, blood vessels, etc.) around the limbs, however, are not affected by the growth plate and continue to grow. This is why some people with hypochondroplasia tend to have bulkier legs and arms, and why limb lengthening is easier. It is

* Words in italics are found in the glossary

as if the muscles were waiting for the bone to finish growing.

Hypochondroplasia is related in many ways to another restricted growth condition called *achondroplasia*, and is often confused at the time of diagnosis. Sometimes people are told that their child has hypochondroplasia to soften the blow because it is seen as a milder form of achondroplasia. But in fact it is a distinct condition. Both are usually caused by changes in the same gene (see below) and both result in shorter arms and legs.



Development of long bones

Hypochondroplasia can usually be distinguished from achondroplasia by different x-ray appearances and the different effects it produces on the body. For example, in hypochondroplasia,the head is much less affected, the pelvis (hip-bone) is normal, the legs may be only mildly bowed and the hand lacks the 'trident' appearance of achondroplasia (where the middle and ring fingers are separated by a gap). In addition, many of the complications that are associated with achondroplasia are less likely to occur in hypochondroplasia.

The average height range for both men and women with hypochondroplasia is between 1m 25cm (4ft 1in) and 1m 60cm (5ft 3in). However, the variation amongst individuals is great, and some may be shorter or taller than this.

Paediatricians and GPs need to bear this in mind when predicting growth rates and expected heights. Ask your clinical geneticist for more information on this subject

Other effects of hypochondroplasia

People with hypochondroplasia are as varied in appearance as people without hypochondroplasia, although as a group they may share certain physical characteristics. These include:

- a near-normal body length with shorter arms and legs
- a tendency towards a large head size with a prominent forehead but normal facial features
- an increased curvature of the lower spine (lumbar *lordosis*)
- mild bowing of lower legs
- short, broad, flat feet and short hands (without the "trident" appearance of achondroplasia)
- limited ability to straighten arms and limited hip joint movement.

The picture opposite shows the physical differences between achondroplasia and hypochondroplasia: the man on the right has achondroplasia and the man on the left has hypochondroplasia.

Children with hypochondroplasia may develop motor skills more slowly than normal, because of the combination of a heavier head with shorter arms and legs. They also may be more floppy than unaffected babies (this condition is known as *hypotonia*). No one knows the exact reason for this but it resolves with time. Talking may also be delayed whilst the child concentrates on becoming mobile, but this is no reflection of

intelligence. Ultimately, overall development is within the expected range, as the following quote from a mother shows:

> *'Jake is extremely active – he plays football, cycles and swims – he never stops.'*

Possible complications

There are some medical complications that are often associated with hypochondroplasia but it can be difficult to know whether or not a particular symptom is related to the condition. Unless the family doctor is familiar with hypochondroplasia (which is unlikely) he or she may be equally uncertain.

Structural difficulties

People with hypochondroplasia lack the unusual facial features and associated problems with skull growth that occur in achondroplasia. Head size may be normal or increased due to a prominent forehead. If complications such as dental crowding and *hydrocephalus* (see glossary of terms) do occur, they are unlikely to be related to the fact that the person has hypochondroplasia.

The back

People with hypochondroplasia may be prone to back problems. The curvature of the spine is often more exaggerated in the lower back (lumbar lordosis) and it is also common for the spinal canal (the space in the backbone that carries the spinal cord from the brain to the body) to be narrower. This narrowing is called spinal *stenosis*. It will be present along the whole length of the backbone, but will be most noticeable in the lower back. The combination of increased curvature and narrowness means that the spinal nerves are more prone to compression or squeezing. This may result in a tingling, numb sensation in the arms or legs (sciatica-like pains). Medical advice

should be sought. Symptoms may initially be alleviated by physiotherapy and the measures outlined below. If this does not work then surgery may be necessary. For example, a procedure known as a *laminectomy* may be used to release pressure from the back of the spinal canal.

'It wasn't until I began to get a lot of back pain when I was in my thirties that I persuaded my doctor to refer me to a geneticist. Once I was diagnosed with hypochondroplasia, the back specialist understood my back problems much better.'

Preventing back problems

Back problems can sometimes be lessened by:

- dietary measures to prevent obesity (in fact, many problems can be avoided or lessened by getting into good eating habits from an early age)
- regular gentle and supported exercise, such as swimming
- avoiding high-risk tasks, such as lifting heavy objects and using poor lifting techniques.

It is important to make sure the backs of young children are always well supported. It is best to avoid

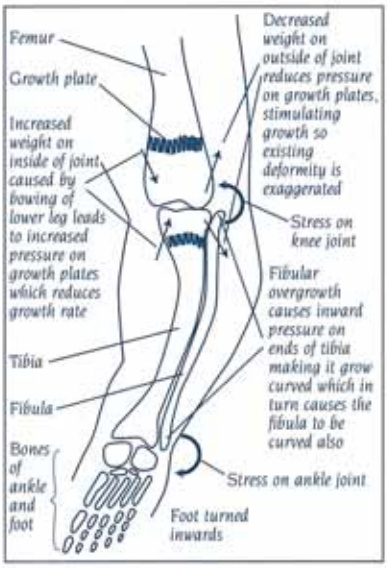
- unsupported sitting and any other activity that involves being in a curved position for any length of time
- the use of baby walkers, jumpers, backpacks and similar items that do not have adequate back support.

Limbs, joints and hips

People with hypochondroplasia may find it difficult to straighten their arms. This is due to the way that the elbow joint is shaped. Movement may become more limited as the person grows older.

The lower legs may be bowed as a result of *fibular overgrowth*. The thinner *fibula* grows more quickly than the thicker *tibia*, causing the tibia to become curved and the

knee and ankle joint to be distorted. This is rarely severe in hypochondroplasia, but if it is orthopaedic surgery, either using fixators or metal plates can correct it. If you are considering leg surgery, please refer to the **Lifestyles** booklet on this topic.



The development of bowing in the lower legs

Some people with hypochondroplasia are affected by hip problems. Curvature of the spine causes the pelvis to be tilted, which in turn reduces free movement of the hip joint. Again, if this severe, it can be corrected by surgically re-aligning the femur.

Medical opinion on the treatment of these problems changes as more is learned about the various conditions. It is important to equip yourself with as much knowledge as possible and to find a doctor with whom you feel happy. The RGA will be able to help you contact specialists with the appropriate experience.

Childbirth

Women with hypochondroplasia are just as capable of having babies as unaffected women, but need to be closely monitored throughout pregnancy. Unlike women with achondroplasia, the pelvis (the hips) is usually normal, so that a vaginal delivery may be possible. In some cases, especially where lordosis of the spine is more pronounced, a planned caesarean

section may be necessary. You will find more information in the **Lifestyles** booklet entitled *Having a Baby*.

Anæsthesia

Anybody with hypochondroplasia who is facing an operation that may require an anaesthetic should make the anaesthetist aware of the condition before the actual operation. Although complications with general anaesthetics are rare in people with hypochondroplasia, the anaesthetist will need to go through your medical history to be prepared for any potential problems (for example, back problems may sometimes complicate a form of local anaesthetic referred to as an 'epidural').

Living with hypochondroplasia

There may be some difficulties associated with having shorter arms and legs and back problems. Extender sticks and steps can help with reaching while 'bottom wipers' can be contrived or purchased to aid personal hygiene (there is more information in the **Lifestyles** booklet *Personal Hygiene*).

Children may need a bit of time in the morning to 'limber up' before they are able to undertake activities which require them to twist, bend and reach. Contact the RGA office for information on a wide range of gadgets.)

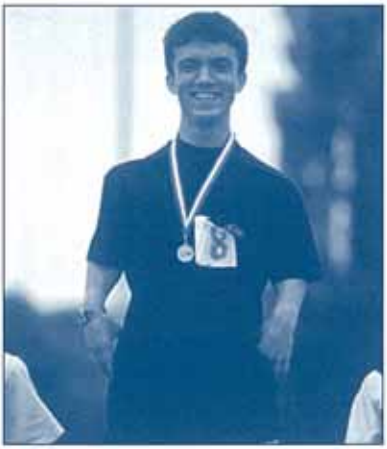
Take the lead

One of the greatest problems for many people with hypochondroplasia is overcoming the prejudice of people who are frightened by anybody who is different.

Parents need to take the lead in discussing their child's height. Children and adults need to learn that the huge diversity that exists amongst people's appearances is a good thing, and that variation in height is just one part of the richness of humanity. Grandparents and other family members,

teachers, doctors and friends will take their lead from parents. If they are able to discuss the issues that their child may face, other people will become more knowledgeable and better able to offer the right kind of support at the right time. It may also help to discuss possible strategies for dealing with inquisitive or insensitive people at school or in the future, and anticipate the questions or comments that may arise.

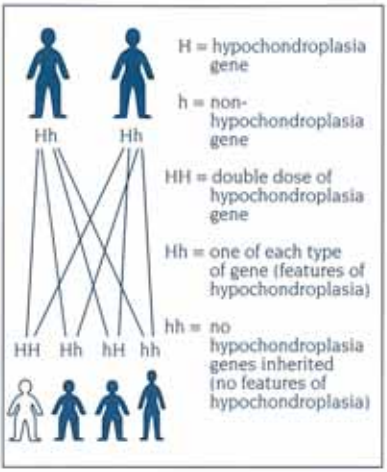
One of the most important things a parent can do to overcome the problems we have considered here is simply to accept their child for who they are and realise that they are unique, with the same individuality and capacity for love as any other child. All of the attributes of good parenting such as listening, education, love, setting a good example and appropriate discipline apply.



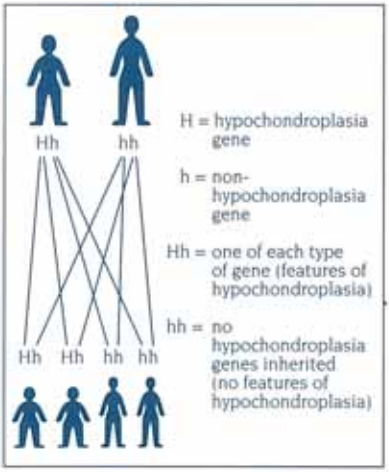
However, it is just as important not to be over-protective. Children need to develop good self-esteem based on their relationships with their parents and with other children. Young people should be encouraged to develop friendships, become involved with school activities (including sport, within the limits discussed above) and gain a good all-round education that will help them in the future. There is more on this issue in several of the **Lifestyles** booklets, but especially *Going to School* and *The Teenage Years*.

child would inherit one copy of the hypochondroplasia gene from either parent and a one in four (25%) chance that the baby would inherit the hypochondroplasia gene from both parents. In achondroplasia this last situation is fatal, and the child does not survive beyond birth. However, it is more difficult to predict what would happen if this occurred in hypochondroplasia. As hypochondroplasia is likely to represent a number of different conditions, each with different genetic changes, the chances of two people with exactly the same condition having children is reduced. A child who receives a 'double-dose' of hypochondroplastic genes is likely to be severely affected and genetic counselling should be sought prior to starting a family.

This is best illustrated in the following diagrams:



Both parents with hypochondroplasia



One parent with hypochondroplasia

'Now Darren has been diagnosed with hypochondroplasia, I know he won't reach six foot like me, but we can still play football together and his skills at ball-handling are so good that I'm proud of him rather than ashamed in front of other dads.'

Parents also need to take the lead in obtaining the most appropriate help and advice for their child. GPs often need to have things explained to them – hypochondroplasia is a rare condition and many doctors have not encountered it before. Parents may need to ask for referral to an appropriate specialist such as an orthopaedic surgeon, back specialist, physiotherapist or other specialist clinics. RGA is assembling the names of specialists with appropriate experience, but in the meantime, parents need to know what to ask and what to ask for. You must become the expert.

Some years ago the following quotation would have summed up the experience of many parents of a child newly diagnosed with hypochondroplasia:

'When I first took Johnny for specialist advice, the doctors hardly knew anything about the condition. They said that hypochondroplasia was the best diagnosis they could give and we were left to our own devices.'

Now, however, there are other possibilities:

'Reading the first draft of this booklet was a delight – there's so much more information than there was available when my son was diagnosed. I'm pleased that other parents will be better informed.'

'It was really good to be put in contact with another family who has a child with hypochondroplasia. Now there is someone I can speak to who understands.'

What causes hypochondroplasia?

All aspects of an individual are controlled by genetic makeup. Genetic material or DNA provides a blueprint for each person and is contained in every single cell in the body. Genes govern the more obvious things like the colour of skin and hair and the shape of the nose, but also extend to the things we can't see, such as the rate of growth, personality, tendencies to certain diseases and conditions. Sometimes a genetic problem arises which affects the aspect of the person controlled by a particular gene.

Hypochondroplasia is caused by a change in the genetic material (or DNA) which provides the blueprint for each individual's appearance. The gene responsible for both achondroplasia and the majority of cases of hypochondroplasia was discovered in 1994. It was found to lie within *chromosome* 4, and it is the code for an extremely important receptor, the fibroblast growth factor receptor-3 (FGFR-3). The FGFR-3 is present in many cells in the body and its full function is not yet known. However, it is known that a problem with this receptor causes abnormal cartilage and bone development and is responsible for several conditions with restricted growth, e.g. hypochondroplasia, achondroplasia and thanatophoric dysplasia. Although the same gene is affected, different changes cause the different conditions. We now know that in childhood, the FGFR-3 is normally switched off, which allows the cartilage to grow. In children with hypochondroplasia, the receptor is active and this is thought to cause inhibit cartilage growth.

Recent work looking into the genetics of hypochondroplasia is starting to reveal that changes in other genes may also produce the same clinical appearance, and that hypochondroplasia may actually represent several distinct disorders

of cartilage growth. Each of these shares similar features but is caused by changes in different genes. In future it may be important for a person with hypochondroplasia, who is considering starting a family with another person of restricted growth, to get a specific genetic diagnosis so that effective *genetic counselling* can be given.

How is hypochondroplasia inherited ?

No one knows exactly how many people have hypochondroplasia because the condition does not have to be registered.

Most children with hypochondroplasia are born to parents of average stature. In these cases, sometime prior to conception, a spontaneous change (mutation) of the FGFR-3 gene occurrs in either the mother's (egg) or father's (sperm) genetic contribution to their child.

Once the change has occurred, a person with hypochondroplasia can pass the condition on to his or her children. However, every individual with hypochondroplasia carries two copies of the gene responsible, one normal and one hypochondroplasia gene. So if one parent is already affected by hypochondroplasia (and the other parent is not), their children have a 50% chance of being affected. This is because hypochondroplasia is an example of a 'dominant' condition where the effects of the hypochondroplasia gene override the effects of the normal gene inherited from the other parent.

If both parents are affected (i.e. each has one copy of the hypochondroplasia gene), the chances of passing on the condition to their children is increased. Such a couple has a one in four (25%) chance of having a child of average stature. There is a one in two chance (50%) that a

If two people of different restricted growth conditions are planning to start a family, they should seek genetic counselling so that they can be advised of the likely outcomes for their child.

Mother and daughter both have hypochondroplasia

Diagnosis and treatment

Genetic Testing

The fact that the gene for hypochondroplasia has now been discovered means that it is theoretically possible to diagnose the condition before birth. This information could, for example, be used to confirm an ultrasound scan diagnosis. However, the test is not used in routine screening because hypochondroplasia is a very rare condition. Indeed, many would argue that the introduction of a routine screening program for hypochondroplasia would demean individuals with the condition and ignore the fact that the majority of people with hypochondroplasia live active, healthy and fulfilling lives.

How is hypochondroplasia diagnosed?

The diagnosis of hypochondroplasia, like all other conditions, is based on a combination of a doctor's suspicion combined with various investigations. However, pre-natal diagnosis can usually only be made with certainty when one or both parents have this condition, as there are other conditions with a similar appearance. After birth the diagnosis can be confirmed on the basis of physical appearance and the results of X-rays. Due to the

fact that the changes in hypochondroplasia may be quite mild, the diagnosis may be missed until the child is older and the shorter arms and legs have become more obvious. Despite this, hypochondroplasia does have certain characteristic X-ray features which doctors will look for in order to confirm the diagnosis. These include:

- short limbs and ribs in relation to trunk length
- a narrow spinal canal in the lumbar (lower back) region of the spinal column
- distinctive (square, short and broad) features of the femoral neck (the top of the thigh bone below the ball joint) when the pelvis is normal
- fingers which are short and of equal length
- a narrow spine which curves inwards.

Treatment

At the moment, there is no single treatment that will result in a child with hypochondroplasia attaining a 'normal' physical appearance by the time they are fully-grown. There is no magic bullet that targets the overactive FGFR-3 receptor, and although trials are ongoing with growth hormone that indicate some success in improving initial growth rate, the increase in final height may not be significant.

The best possible treatment consists of a sensible diet, regular gentle exercise and routine check-ups by the paediatrician throughout childhood to identify

and treat any of the complications of hypochondroplasia as soon as they arise. Most of these complications and their prevention or treatment have been mentioned above.

Surgery can be used to lengthen the arms and legs of people with hypochondroplasia. However, this remains a controversial issue amongst affected people. It is not without complications, and the process can often be long and painful. It is no magic wand and should be considered only when the affected youngster has had an opportunity to develop good self-esteem and a positive self-image and can fully participate in any discussion concerning its use. This is one of the reasons why the RGA encourages its young members to socialise together and develop positive attitudes. Unfortunately, this surgical procedure is sometimes offered by doctors who have no concept of the psycho-social issues facing the young person.

Sources of information

Research is ongoing into the genetics and the effects and treatment of hypochondroplasia.

In this country the largest organisation for parents, their children and other individuals with hypochondroplasia is the Restricted Growth Association. The RGA is a self-help organisation concerned with the welfare of people of restricted growth. Members maintain contact through a magazine, meetings, conferences and social activities. There is a support network for families and medical information is provided. The RGA is also compiling a list of specialists who have expertise in symptoms related to hypochondroplasia. Our address is:

Restricted Growth Association
PO Box 8, Countesthorpe,
Leicestershire LE8 5ZS
Tel: 0116 2478913

Another organisation in the UK is the Child Growth Foundation. This campaigns for the screening of growth in children and funds research into the treatment of growth disorders. Their address is :

Child Growth Foundation
2 Mayfield Avenue, Chiswick,
London W4 1PW
Tel: 0181 995 0257

The Skeletal Dysplasia Group (for medically or scientifically qualified people) aims to find out more about developmental disorders of skeletal growth. They have a list of publications, which are available directly from:

The Skeletal Dysplasia Group for Teaching and Research
2 Dale Close, Oxford OX1 1TU

The Dwarf Athletic Association makes regular sporting opportunities available to people of short stature. Their address is:

The Dwarf Athletic Association
C/o 44 Middlecroft Road,
Stourton Grange, Leeds LS10 4QZ
Tel: 0113 2703791

If you have access to the Internet, several organisations and individuals have created web pages dedicated to providing information on conditions with restricted growth. One such group is the Little People of America, the American equivalent of the RGA. Their web page can be found at http://www.bfs.ucsd.edu/dwarfism/lpa.htm

The following sources have been useful in compiling the **What is...** series of booklets :

Greenberg Center for Skeletal Dysplasias – Web site: http://www.med.jhu.edu/Greenberg.Center/Greenbrg.htm

American Academy of Pediatrics. (1995) 'Health Supervision for Children with Achondroplasia'. *Pediatrics*, Mar 95, 443-451.

Beighton P. (1978) *Inherited Disorders of the Skeleton*. Churchill Livingstone, Edinburgh.

Curcione P.J. and Stanton R.P. (1995) 'Multiple Epiphyseal Dysplasia'. Clinical Case Presentation obtained from the Internet site of the Alfred I. Dupont Institute, Wilmington, Delaware, USA.

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Jones K.L. (1988) *Smith's Recognizable Patterns of Human Malformation*. 4th Edition. WB Saunders, Philadelphia.

McKeand J., Rotta J. and Hecht J.T. (1996) 'Natural History Study of Pseudoachondroplasia'. *Am. J. Med. Genetics* 63: 406-410.

Online *Mendelian Inheritance In Man* – Web site: http://www3.ncbi.nlm.nih.gov/Omim/

Rimoin D.L. and Lachman R.S. (1990) 'The Chondrodysplasias'. *Principles and Practice of Medical Genetics*. Eds A.E.H. Emery and D.L. Rimoin; London: Churchill Livingstone, 2nd edition.

Rousseau F., Bonaventure J., Legeai-Mallet L., Schmidt H., Weissenbach J., Maroteaux P., Munnich A. and Le Merrer M. (1995). 'Clinical and genetic heterogeneity of Hypochondroplasia'. J. *Med. Genet*, 33: 749-752.

Skeletal Dysplasia Group for Teaching and Research – Occasional Publications 5b, 6b, 8b and 9 – Hall M, Hurst J., Slaney S. and Wynne-Davies R. (1998).

Wynne-Davies R., Hall C.M. and Appley A.G. (1985) *Atlas of Skeletal Dysplasias*. Churchill Livingstone, Edinburgh.

Glossary of terms

Achondroplasia – a form of disproportionate stature caused by changes in the same gene as hypochondroplasia. See *What is Achondroplasia?*.

Autosomal dominant/recessive – these terms refer to the ways in which individual genes can be inherited. *Autosomal* means that the gene lies on a non-sex chromosome (there are two types of sex chromosomes: x and y, which determine whether you are male or female). *Dominant* refers to the fact that only one copy of the gene is necessary for the condition to be present. *Recessive* means that two copies of the gene are required.

Chromosomes – One of 46 structures present in most cells in the body that are composed of long coiled strands of DNA and carry genetic information in the form of genes. Germ cells, i.e. sperm and eggs, only carry 23 chromosomes.

Diaphysis – the shaft of the long bone.

Epidural anaesthetic – a form of anaesthetic which uses the epidural space (a space around the spinal cord) to numb spinal nerve routes providing pain relief during procedures such as childbirth.

Epiphysis – the end of the long bone which is normally separated from the shaft by the growth plate (the area of cartilage where bone growth occurs). It becomes fused to the bone shaft during puberty to form a complete bone.

Fibular overgrowth – Sometimes the *fibula* (the thinner of the bones in the lower leg) grows more quickly than the thicker *tibia*. This results in curving of the lower leg and distortion of the knee and ankle.

Gene – a unit of genetic material which carries instructions for growth, development, the regulation of the bodies internal workings, etc. Genes are grouped together on chromosomes.

Genetic counselling – the process by which knowledge and advice concerning inherited disorders and the possibilities of passing on particular conditions from one generation to the next, together with possible options regarding diagnosis and management, are given to affected people and their families

Growth plate – the area of the bone where cartilage cells divide and grow, allowing the bone to increase in length.

Hydrocephalus – an increase in pressure of the fluid that lies within the ventricles of the brain (the normal spaces that lie inside the brain) that causes the head to swell in childhood and can be life-threatening. It is more common in achondroplasia due to the problems of skull growth in childhood and is extremely rare in hypochondroplasia.

Hypotonia – excessive 'floppiness' caused by insufficient muscle tone.

Laminectomy – Surgical operation to relieve pressure on the spinal cord. By cutting into the rear part of the vertebrae, conditions such as spinal cord compression, a common feature of hypochondroplasia, can be relieved.

Lordosis – inwards curvature of the lower spine.

Metaphysis – part of the bone lying between the epiphysis (end of the bone) and the diaphysis (the shaft of the bone).

Stenosis – narrowing of an opening, for our purposes the spinal canal or the foramen magnum (at the base of the skull).

List of publications available from the Restricted Growth Association

What is . . .?

Achondroplasia

Hypochondroplasia

Pseudoachondroplasia

SED

MED

Diastrophic Dysplasia

Rarer Syndromes

Lifestyles

Babies and the Early Years

Going to School

Driving a Car

Bikes, Trikes and Ride-on Toys

The Teenage Years

Sporting Opportunities

What Shall I Wear?

Having a Baby

The Later Years

Adoption

Careers, Employment and Education

Limb Surgery

Personal Hygiene

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