Human Growth Hormone – neither undetectable nor harmless

What is human growth hormone?

Growth hormone (GH) is a natural peptide hormone secreted by the pituitary gland of the brain. Previously, the only source of human GH (hGH) was human cadavers, but the potential to transfer the dreaded Kreutzfeldt-Jacobs disease made this practice obsolete. Since the late 1980s, recombinant human GH (rhGH) has been developed and is used clinically with good results in patients lacking the hormone.

Its abuse in sport was suspected because of its anabolic properties. Athletes and body-builders claimed that hGH increased lean body mass and decreased fat mass. Today, the use of hGH in sport is based not only on its anabolic properties, but also its effect on the metabolism of carbohydrate and fat.

Since 1989, international federations and the IOC have listed hGH as a of forbidden substance, when it became obvious that biotechnology products like rhGH could be more easily obtained on the regular and the black markets. On the 2006 FIFA list of prohibited substances, hGH belongs to category S2 “hormones and related substances”.

Growth hormone action

Human GH secretion in the body is pulsatile, with the highest levels observed at puberty and decreases with age by around 14% per decade. Moreover, hGH secretion varies under different conditions being higher during slow-wave sleep, exercise, stress, low concentration of blood glucose and fever. Some specific drugs as well as androgens and estrogens increase its secretion, too. HGH secretion is decreased by obesity, a carbohydrate-rich diet and the so-called beta-2-agonists.

Exercise increases hGH concentration in blood with time for a given work intensity up to 10-fold during prolonged moderate exercise and even more during more intensive exercise with lactate formation. It appears that hGH response is more closely related to the peak intensity of exercise than to the total work output.

Recently, due to the better availability of the recombinant hormone, hGH deficiency in adults has been studied more extensively. In these individuals, four to six months hGH therapy shows favourable effects on body composition, exercise aptitude, kidney and heart functions and generally improves the quality of life. HGH increases the muscle mass and total body water while it decreases the fat mass. The rhGH dose in adults is individual, but the typical dose for medical reasons is 1-2 IU injected into the fat underneath our skin every evening. These therapeutic doses show no adverse side-effects.
HGH in sport

Since the late 1980s, abuse of rhGH in sport has increased steadily. The popularity of the product is based on the widespread knowledge that it is efficient, hard to detect and without major side-effects if well dosed.

Underground information suggests that athletes are taking 10-25 IU/day 3 to 4 times a week to increase their lean body mass. It is supposed that about 4 IU/day is used in combination with other doping agents such as anabolic steroids in power sports or EPO in endurance sport.

The treatment is often applied in cycles of four to six weeks similar to what is done for anabolic steroids in bodybuilding. In endurance sport, very little is known on the optimal use of hGH when combined with other products - it is totally individual and empirically based.

To what extent hGH actually improves performance is still under debate among users. The positive effects described with hGH-deficient adults are not so clear for athletes. Although many underground reports indicate some positive effect on muscle mass, it is difficult to determine the benefits obtained when hGH is taken in combination with anabolic steroids. Since the objective results of scientific studies are generally not in agreement with subjective reports by abusers, it is difficult to draw conclusions regarding the true effects of excessive hGH doses on muscle function.

Dangers of using hGH

The long-term risks of hGH are not well known since there are no epidemiological data regarding its use in healthy sportsmen. Acromegaly, which occurs when production within the body is increased, is often cited as a major risk of excessive use. The major symptoms are swelling of the hands and feet, coarsened facial appearance, dentition problems, joint pain, fluid retention and excessive sweating. Long-term hGH doping with high doses increases the risk of diabetes, hypertension, heart muscle damage, osteoporosis, menstrual irregularities, impotence and unfavourable changes of the lipid profile in blood.

Since hGH needs to be injected, there is a risk of infections such as HIV/AIDS and hepatitis if syringes are non-sterile or contaminated. The use of cadaveric GH is feared because of the risk of developing Creutzfeldt-Jacob disease, a slowly progressive dementia.

Detection of hGH doping

Doping with hGH was considered undetectable until the Olympic Games of Athens 2004. It does pose several challenges to the laboratories: hGH appears only briefly in blood (i.e. it has a short half-life) and in low concentration in urine. As a peptide it cannot be detected by the classical analysis methods for anabolic steroids or stimulants with their relatively low molecular weight. The amino acid sequence of the recombinant molecule is identical to the natural hormone. In addition, as mentioned, the secretion of hGH is highly variable, both intra- and inter-individually. Quantifying the hormone itself is not sufficient to detect exogenous rhGH.
... in the urine

Some attempts to use urine for analysis have been conducted because it is convenient and the relatively unlimited in volume. However, the only way to detect hGH in urine is an extremely sensitive immuno-test to quantify the total amount of the hormone in urine and the limitations of that test have been clearly demonstrated.

... in the blood

Many investigations have shown that an indirect test in the blood can be used for screening and targeting purposes. There are several markers that help define the normal ranges in individual athletes. These indirect screening test identify suspicious samples that can be subjected to a direct test for hGH.

The direct method in the blood is based on the fact that rhGH only exists in one native isoform, whereas the circulating hGH in human blood is present in several forms. Therefore, when rhGH is injected into the body, this will increase the ratio of this isoform in relation to all other circulating forms.

Recent immunotests are able to quantify several types of hGH isoforms. The detection window for these tests is between 24 to 36 hours after the last injection, depending on the dosage used. It is supposed that hGH doping, to be effective, needs multiple injections. The direct test is not influenced by environmental parameters such as exercise or stress. If applied in out-of-competition tests, direct tests should be a deterrent.