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Osteoporosis in males. Treatment

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Introduction

Since the initial description of postmenopausal osteoporosis in 1941, Osteoporosis (OP) has been considered a disease which appears in women. However, since a few years ago, it has been recognised that OP in men represents a significant problem in public health, since a seventh of vertebral fractures and a fourth to a fifth of all fractures of the hip occur in males, causing significant morbidity-mortality¹.

Epidemiology of male osteoporosis

There are not many works on the prevalence of male osteoporosis in different populations. It is calculated that some 2 million American males may have OP and that it will increase 20% by 2015. In our experience, the percentage of densitometric OP in the Spanish male population is 4.15% (2.99%-5.31%), which would suppose that there would currently be between 418,000 and 743,000 Spanish males affected².

Incidence and prevalence of fractures in men Incidence of hip fractures

The proportion of hip fractures in the male population represents 30% of all hip fractures in the world³. The life risk for hip fractures in men is 6% at the age of 50 years. In 1996 there were 80,000 hip fractures in American men. For the year 2025 an increase in these figures is foreseen.

The MEDOS (Mediterranean Osteoporosis Study) study⁴, carried out in the Mediterranean basin, and in which this country participated, it was observed that the incidence of hip fracture due to OP in individuals of more than 45 or 50 years, varied in the case of men, between 50 and 100 cases per 100,000 inhabitants per year. In our

country it has been estimated that the incidence of hip fractures in those older than 50 years varies between the 127.8/100,000/year of Gran Canaria and the 267.7/100,000/year of Valladolid⁵, with a female/male ratio of between 2.5-3 to 1.

The morbidity-mortality of hip fractures is greater in men than in women. 36% of men with hip fractures die in the year following the fracture⁶.

Prevalence of vertebral fractures

Vertebral fractures are more common now than was previously thought, although only 1/3 of them are symptomatic. In the EVOS (European Osteoporosis Vertebral Study) study, the standardised prevalence of vertebral deformity in people older than 50 years was similar in both sexes, with figures of 20.2% using the Eastell criteria and 12.0% using those of McCloskey, with significant variations between countries of similar latitudes, the rate in Spanish males being 572 per 100,000 inhabitants⁷.

The vertebral deformities and their negative impact on health (back pain, reduced functional capacity, and global subjective feeling of health) was more significant in men than in women.

Mortality after vertebral fractures is higher in males. The work of Center et al.⁸, showed that after the first year after fracture, the increase in global mortality was 1.66 for women and 2.38 for males. In patients clinically diagnosed with osteoporotic vertebral fracture there is an excess in mortality of 17% at five years⁸. It is possible that other risk factors are associated with this, such as age, smoking, alcohol consumption, immobility or, as well, chronic processes such as chronic obstructive pulmonary disease, gastrointestinal disease or infection.

Aetiology

From the clinical point of view, it is important to understand that roughly between 50-60% of men with OP have some dysfunction or condition which favours its appearance⁹⁻¹¹. Standing out among these are hypogonadism^{10,12,13}, taking of steroids¹⁰, hyperthyroidism, primary hyperparathyroidism, chronic alcoholism¹³, gastrointestinal disorders, idiopathic hypercalciuria, malignant diseases and prolonged immobilisation.

In relation to hypogonadism, it is necessary to highlight the fact that long-term testosterone deficiency is typical in 30% of men with vertebral OP. It commonly appears in the sixth decade of life and the great majority have had symptoms related to hypogonadism for 20 to 30 years. Whilst deficiency in testosterone is related to a greater affection in trabecular bone causing vertebral OP, the affectionation of cortical bone may also be affected due to chronic testicular hypofunction, especially before the closure of the epiphyses¹⁴. The androgenic deficiency reduces the synthesis of 1.25-dihydroxyvitamin D provoking a reduction in intestinal absorption of calcium (Ca) as well as provoking a reduction in bone formation¹². Gonadal deficiency may be a risk factor for the appearance of hip fractures, and may also contribute to the reduction in bone mass associated with aging.

Pathogenesis of primary male OP

Although in women the ceasing of gonadal function during the menopause is the predominant pathogenic factor, this probably does not happen in men, where most important are the secondary causes and other risk factors. There are various published studies which relate risk factors with fractures in males¹⁵⁻¹⁸. Thus, the EVOS study¹⁵, found a direct relationship with age, with the existence of a previous hip fracture, with lack of physical exercise or with excess physical activity in middle age, with a low body mass and with previous use of steroids.

The low incidence of male OP in relation to female, is related to different mechanisms which are summarised in Table 1.

Men have larger bones and the maturing of the axial and appendicular skeleton is faster in women than in men of the same chronological age¹⁹, due to the greater speed of growth and the duration of the pubertal growth spurt. Hence, late or early puberty causes a deficit or excess of size, mass and density of bone (BMD) depending on when the disease occurs²⁰.

The growth phase is important, considering the different pattern of growth of the axial and appendicular skeleton and the changes in bone mass which occur during growth and aging. Men have a peak bone mass (PBM) higher than that of women²¹ because they have a net gain of around 300 g more of bone Ca during growth, than women (1,200 g vs 900 g of total body Ca). The PBM in both sexes is influenced by different factors: nutrition, physical activity, genetic potential and other factors. Women show an increase in

Table 1. Mechanisms which contribute to lower bone fragility in males compared to women

- Greater size of bone structures
- Higher "peak bone mass"
- Lower loss of bone mass, over time
- Less trabecular perforation and disconnection with thinning of the trabeculas, as a result of a reduction in bone formation.
- Less thinning of the cortex, as a result of a higher periostic apposition and a lower endosteal resorption

bone mass at the start of adolescence, completing it at the end of puberty. In men, as the start of puberty is later, PBM is reached later too. The differences in PBM and bone size explain the difference in the pattern of fractures which it produces in later stages of life. The loss of bone mass is later than in women, although the absolute quantity of loss of trabecular bone in the iliac crest is similar in both sexes. Men lose only around 100 g net of bone Ca during aging, while women lose nearly 250 g of Ca.

With aging there is a continuous growth in periosteum in men, but not in women, hence bone size is greater in males²². The mechanism of this continuous growth is unknown, but it is thought that it may be due to a phenomenon related to sex hormones. Men lose around 10% of their PBM during aging, while in women this loss can be up to 30%. These great differences in bone size and in BMD would explain the lower incidence of fractures in men compared to women.

The levels of blood testosterone reduce with age due to the reduction in the number of Leydig cells, to changes in hypothalamus/hypophysarial function and disease. There is an association between testosterone and BMD in men; in the institutionalised aged the levels of testosterone are correlated with BMD in the femoral neck, with low levels reported in 59% of patients with vertebral fractures compared to 18% in the control group¹⁴.

The association between bone mass and testosterone has been reported in a minority of studies^{22,23}, while other studies have not found such a relationship²⁴.

On the other hand, the growth hormone (GH) and IGF1 can take a significant role in the reduction of bone formation during aging. Both hormones diminish with advancing age^{25,26}, it having been confirmed that IGF1 and IGF BP3 are positively associated with BMD. In fact IGF1 can be reduced in men with fractures. In addition, it is known that aging is associated with a reduction in blood levels of dehydroepiandrosterone sulphate (DHEA), with treatment with DHEA having been shown to increase levels of IGF1 and reduce IGF BP3, by which the ratio IGF1/IGFBP3 is increased by 50%, which increases the bioavailability of

IGF1. We also know that testosterone increases IGF1, from which it can be deduced that the effects of testosterone can be partly mediated through GH²⁷.

Diagnosis

The diagnosis of OP in men is established with a good clinical history, a physical examination, a lateral dorsal and lumbar X-ray, and the measurement of BMD. The majority of patients attend the clinic once an osteoporotic fracture has appeared, and there are only few occasions in which the diagnosis is performed before they occur¹⁰. The problem is to establish the etiological diagnosis to determine the appropriate treatment. An correctible cause of low BMD needs to be excluded, for which reason an analytical study is carried out which includes an elemental examination of the blood, with complete biochemical profile which includes blood proteins and protein immunoelectrophoresis, thyroid hormones, testosterone, luteinising hormone (LH), prolactin, urinary calcium excretion in 24 hours. The determination of cortisol is carried out in any man with OP when the aetiology is not apparent. Subsequent studies are carried out if anomalies are found in earlier analyses, for example, if there is hypercalcemia, the PTH is determined, if there is hypocalcemia, hypocalciuria and/or hypophosphatemia with an increase, or not, of levels of alkaline phosphatase, levels of vitamin D will be determined. If there is diffuse bone pain, or any anomaly in the haematological profile, a bone X-ray and a biopsy of the bone medulla are carried out. In institutionalised patients it is recommended that a screening is carried out to determine vitamin D and evaluate its deficit. A diagnosis of idiopathic OP is carried out when a secondary cause of OP has been ruled out.

Treatment of osteoporosis in males

Although great advances have been made in the understanding of the epidemiology and pathology of male OP, this is not the case with treatment. Differently from female postmenopausal OP, there are few conclusive studies on the results of treatment of osteoporosis in males. The majority of studies have had as their primary objective changes in bone mass, and not the prevention of fractures, having small sample sizes. In addition, they include non-homogeneous populations, both in their aetiology –males with idiopathic OP and OP due to hypogonadism– and with different diagnostic criteria.

The treatment of OP in men consists fundamentally in identifying secondary causes, and maintaining a balanced diet, with an adequate intake of Ca, and in those cases where this may be insufficient, administering Ca and vitamin D, avoiding inactivity, taking adequate physical exercise or a programme of physiotherapy. In very old or frail males with OP, measures should be taken to minimise the risk of falls and to reduce their impact²⁸.

In patients with hypogonadism treatment with testosterone should be tried. Replacement with

long-acting preparations of testosterone should be considered in all osteoporotic or osteopenic patients with low levels of blood testosterone. Generally this is well tolerated. The few available studies on the effects of androgens in older males with idiopathic OP do not allow a recommendation of their use in the absence of evident hypogonadism. A meta-analysis has been published on the effects of testosterone on males at risk of OP (hypogonadal men, very old men or those on corticoid treatment) which concludes that intramuscular testosterone –but not transdermic administration– moderately increases lumbar BMD without being able to infer results on fractures²⁹. Precautions should be taken with patients with prostatic hyperplasia, since there is a risk of prostatic cancer, it being contraindicated in patients with prostate cancer. It is recommended that a digital rectal examination and prostate specific antigen (PSA) test be carried out in all men over 50 years of age who are going to receive androgenic therapy, as well as during the follow up period. Although no changes in levels of blood lipids have been shown, its use is not recommended in men with hypogonadism and a significant history of ischemic cardiopathy.

Calcium and vitamin D; vitamin D derivatives

As is the case with women, there is agreement in recommending the use of Ca and vitamin D supplements in male patients with osteoporosis, even when there is no clear proof available with respect to their efficacy, with the aim of avoiding negative consequences, in which, at least theoretically, a lack of them could result.

The scarce data available does not allow the establishment of recommendations on the use of alphacalcidol, calcitriol or other derivatives of vitamin D for OP in males³⁰.

Calcitonin (CT)

The few available studies suggest that nasal CT (200 UI/day), continuous or intermittent, produces an increase in lumbar BMD and a reduction in markers for bone remodelling in males with osteoporosis³¹. The data on femoral BMD are contradictory. There are not sufficient quality data to pronounce on CT's effect on the reduction in the occurrence of osteoporotic fractures.

Etidronate (EDPN)

Not a single controlled clinical trial has been identified, so it is not possible to establish recommendations with respect to its use, although a recent publication shows that both EDPH and ALN are associated with gains in lumbar BMD (higher for ALN) and suggests a positive effect on femoral BMD and on fractures of both biphosphonates (BF)³².

Alendronate (ALN)

The most important trial on the effect of ALN on males with primary OP (associated, or not, with low blood levels of testosterone)³³ included 241 males with an average age of 63 years (between

31 and 87 years). The primary objective was the change in lumbar BMD. More than 80% of the subjects completed the study (86% for ALN and 83% for the placebo). With the incidence of vertebral fractures measured by quantitative methods the difference was statistically significant: 0.8 vs 7.1% (-88.7%, ALN vs placebo; $P = 0.02$). Those treated with ALN also presented a lower loss in height (0.6 vs 2.4 mm; $P = 0.02$).

This cohort was analysed again after 3 years of treatment³⁴. 118 subjects (88%) finished the trial. Seven subjects treated with ALN (7/68, 10.3%) and 16 with alphacalcidol (16/66, 24.2%) developed vertebral fractures, which suggests a significant reduction in risk of 57% ($P = 0.04$). Those treated with ALN also lost less height during the trial (7.1 vs 13.1 mm, $P = 0.03$). The difference in non-vertebral fractures (6 with ALN -8.7%-, and 8 with alphacalcidol -12.1%-) and in vertebral pain was not significant. Adherence to both treatments was higher than 90%, and they were well tolerated.

Also assessed were the effects of weekly treatment with ALN in male idiopathic osteoporosis and that associated with hypogonadism (40% of the total number of subjects; 57% older than 65 years)³⁵. This was a randomised placebo-controlled double blind trial of 12 months duration which included 167 males with T-scores < -2 and/or fractures (more than 60%) treated with Ca and vitamin D and randomly assigned (2:1) to either ALN (70 mg/week) or placebo. 86% of the subjects completed the study. Two subjects developed 2 non-vertebral fractures (one in each group). Nine subjects showed vertebral fractures 6 (7.5%) with ALN and 3 (7.3%) in the placebo group (4.6% of those treated with ALN and 5.2% of the placebo group suffered clinical fractures). Weekly ALN was associated with a significant increase in BMD in the lumbar region (4.3%), femoral neck (+2.1), trochanter (2.4%) and total body (1.4%) with respect to the initial value and the placebo group ($P < 0.05$), independently of gonadal state, weight or height.

In conclusion, ALN is associated with a significant increase in lumbar, femoral and total body BMD in subjects with idiopathic OP and with OP associated with hypogonadism, as well as a significant reduction in markers for remodelled bone. Daily ALN has shown, although a secondary objective, a significant reduction in risk of vertebral fracture.

Risedronate (RSN)

Sato et al.³⁶ assessed the effect of RSN on Japanese males of advanced age (> 65 years, average age 76 years) with hemiplegia due to cerebrovascular accident. Those subjects with previous fractures were excluded and the presence of densitometric OP as a criterion for inclusion, was not required. The primary objective was the incidence of hip fractures. 280 subjects were randomly allocated to receive 18 months of treatment with RSN. There were 10 hip fractures in the placebo group (10/133, 7.5%) as opposed to 2 in the RSN group

(2/134, 1.5%). The relative risk was 0.19 (interval of confidence of 95% 0.04-0.89). All the fractures occurred on the hemiplegic side. The bone mass assessed by radiogrammetry increased by 2.5% with RSN, while it was reduced by 3.3% in those receiving the placebo ($P < 0.001$).

An open study which analysed the effects of RSN vs placebo over 12 months in males with OP or secondary OP showed a reduction of 60% in the appearance of vertebral fractures³⁷.

Ibandronate (IBN)

We did not find in the bibliographic search a single controlled trial on the effects of IBN on males with OP. One open study, not controlled, with intravenous IBN (2 mg/3 months) along with calcium and vitamin D, showed an increase in lumbar BMD of 6.7% and of 3.2% in the femoral trochanter at 2 years³⁸.

Thiazides

Despite not having been able to identify a single clinical trial on its effects on males with osteoporosis, the available evidence suggests an interest in the use of the thiazides in osteoporotic males with concomitant hypercalciuria³⁹.

Fragment 1-34 of PTH (PTH 1-34) or teriparatide

One of the first studies carried out to evaluate the potential anabolic effect of fragment 1-34 of PTH in males with idiopathic OP was a placebo-controlled double blind trial carried out in 23 males (average age 50 year, range 30-68 years)⁴⁰, in which were included subjects with values of BMD of OP in the lumbar spinal column or femoral neck. All had either previous osteoporotic fractures (78%) or vertebral pain (22%). The subjects were randomly selected to receive 18 months of treatment with 400 UI of PTH 1-34/day subcutaneously ($n = 10$) or placebo, also subcutaneous ($n = 13$). Only one subject, (4.3%), (in the placebo group) abandoned the trial. All received daily supplements of Ca and vitamin D to reach an intake of 1,500 mg and 400 UI respectively. Seven subjects had receive other treatments earlier (3 in the placebo group (23%) and 4 (40%) in the PTH 1-34 group).

All the markers for remodelled bone analysed in the study increase significantly in the patients treated with PTH 1-34. The most marked changes were those of bone alkaline phosphatase which reached its peak at 9 months (+168%, $P = 0.053$), remaining increased until the end of the trial (43%; $P < 0.005$), and those of osteocalcin (BGP) which showed changes of the greatest magnitude (% $P < 0.001$) after 12 months of treatment (+150% at 18 months, $P < 0.005$). Among the markers for resorption, urinary NTX reached a peak at 12 months (+375%, $P < 0.001$) remaining elevated at 18 months (+261%, $P < 0.005$). Two subjects treated with PTH 1-34 (2/10, 20%) showed hypercalcaemia which disappeared as the dose of PTH 1-34 was reduced. No increase in calciuria was detected.

The treatment with PTH 1-34 was associated with a progressive increase in lumbar BMD of 13.5% in 18 months, as opposed to a stabilisation of BMD in the placebo group ($P < 0.001$). In the femoral neck a significant increase in BMD was also produced (2.9%; $P > 0.05$ vs placebo). The BMD of the total femur did not change significantly, whilst in the third distal radius, even without significant changes from initial values, there was a reduction compared with the placebo group (-1.2 vs + 0.5%, $P < 0.05$).

The most important trial carried out in males with teriparatide⁴¹ includes 437 caucasian subjects with osteoporosis (T-score < -2 in the spinal columns and/or proximal femur, total hip or femoral neck). Around 50% of the patients had low blood levels of testosterone. The average age was 59 years, and intake of calcium 0.8 g/day. 15% had received previous treatment for osteoporosis. No information was given on the prevalence of osteoporotic fractures. The subjects were randomly selected (the design was controlled double blind) to receive treatment with placebo ($n = 147$) or with 20 ($n = 151$) or 40 ($n = 139$) mcg/day of teriparatide subcutaneously. All the subjects received 1 g/day of Ca and 400-1,200 IU/day vitamin D. In cases presenting with hypercalcemia, hypercalcuria, nausea or headache, the supplements of Ca may be reduced or stopped –which is what was done with 16 patients treated with teriparatide– and this dose can even be reduced to half –which was done with 7 patients treated with 40 mcg/day–. Compliance was estimated at 77% and 81 of the 437 subjects (18.5%) abandoned the trial before its completion. The duration foreseen of the trial was 2 years, but the development of osteosarcoma in an experimental study in rats who had been treated almost all their lives with teriparatide resulted in the organisers stopping the trial prematurely, which meant that the average exposure to teriparatide was 11 months, slightly less in those treated with teriparatide (15 to 26 days less, $P < 0.05$).

The markers for remodelled bone increase dose-dependently. Bone FA increased 30 and 60% at the end of the study (for 20 and 40 mcg/day $P < 0.001$ vs placebo, peak between 6 and 12 months), the blood PICP showed a maximum peak at the month of treatment (+35 and + 75 for 20 and 40 mcg/day) and later decreased until it reached initial values. The markers for bone resorption increased significantly in the groups treated with teriparatide later than those for formation (by the end of the NTX trial: 50 and 120% and D-pyr: 40 and 75% for 20 and 40 mcg/day, respectively).

The patients treated with teriparatide showed an increase in lumbar BMD of 5.9 and 9.0% (for the doses of 20 and 40 mcg/day respectively, $P > 0.001$ vs placebo), the increase was evident after three months of treatment. Femoral BMD increased by 1.5 and 2.9% (for 20 and 40 mcg/day, $P < 0.05$ and 0.001, respectively), while that of the whole body increased 0.6 and 0.9% (for 20 and 40 mcg/day, $P < 0.05$ and 0.01, respectively). There were no significant changes in the BMD in the dis-

tal radius. The increases in BMD were independent of the functional state of the gonads, age, initial BMD, body mass index, tobacco smoking or alcohol intake.

Only non vertebral fractures were noted, which showed no significant difference between the groups (3,2 and 1 for the placebo group, and those on 20 and 40 mcg/day respectively).

Hypercalcemia was present in 0% (placebo), 6.2% (20 mcg/day) and 16.8% (40 mcg/day) of patients, respectively, at 4-6 hours after the injection, but none presented with hypercalcemia at 16-24 hours after the dose. No patients in the placebo group and only 1.4% of those males treated with teriparatide presented hypercalciuria in 2 consecutive samples. One patient in the placebo group, one in the group on 40 mcg/day of teriparatide and two in the group on 20 mcg/day needed adjustments to the dose of Ca, whilst none from the three groups required a reduction in the dose of the drug being administered. One male (0.7%) from the group on 20 mcg/day was withdrawn from the study due to the presence of hypocalciuria.

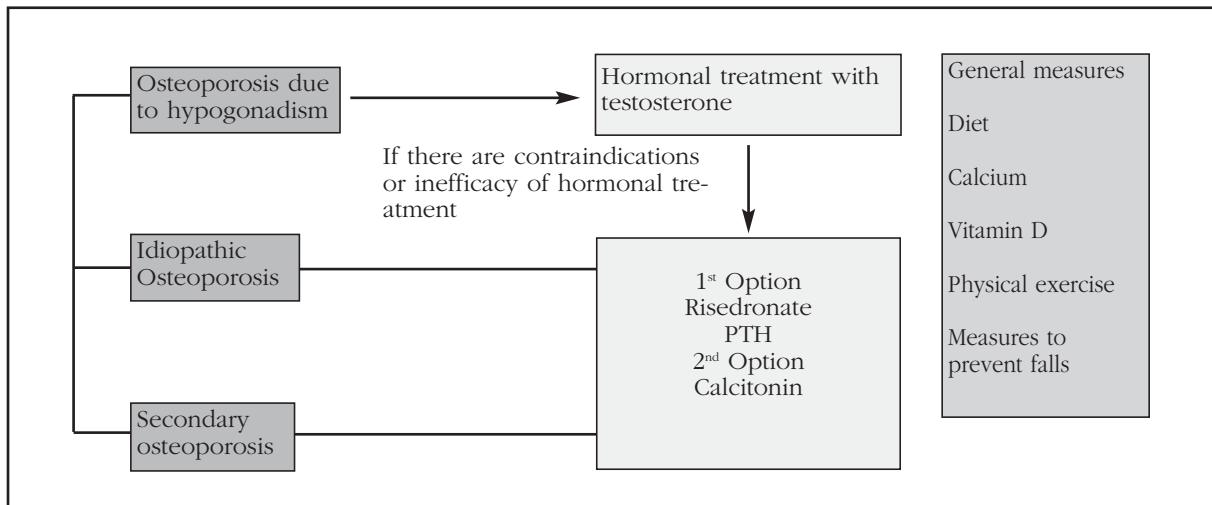
The levels of abandonment due to adverse effects were similar in the placebo group and in that on 20 mcg. These were 4.8% (placebo), 9.3% (20mcg/day) and 12.9% (40 mcg/day) ($P = 0.052$). The most frequent of these effects were nausea (3.4% (placebo), 5.3% (20 mcg/day) and 18.7% (40 mcg/day); $P < 0.001$, 40 mcg/day vs placebo) and headache (which was also most frequent in the group on 40 mcg/day at 10.8%).

More recently Kaufman et al.⁴² have published the results of a study of a follow up of up to 30 months after treatment of the same group of patients (42 months of observation in total). 355 males with an average age of 59 years and of whom 41% had previous fractures, participated. Even though the primary objective was the safety of the drug, the change in BMD was assessed at 6,12 and 18 months and spinal X-rays were carried out at 18 months. The study consists, therefore, of a follow up of the subjects who, after having completed the study, were treated according to usual clinical practice, meaning that 25 and 29% were in treatment with other drugs (75% BP) for 18 to 30 months of follow up. At the last visit, the use of treatment for OP was significantly higher in those subjects who had been receiving the placebo in the original study, compared with those who had received teriparatide ($n = 46$; $n = 58$, 25% respectively; $p = 0.03$).

A progressive reduction in BMD was obtained during the follow up, however, both the lumbar BMD and that of the total hip remained significantly higher than the initial value (4-6% in the spine and 1-3% in the hip, in those individuals previously treated with 20 and 40 mcg/day, $P < 0.001$). The subjects who were treated with anti-resorptives showed an additional increase in BMD.

Among those 279 males for whom were available the lateral spinal X-ray at the start of the original trial and at 18 months from the discontinua-

Figure 1. Treatment algorithm for osteoporosis in males. The secondary causes of osteoporosis in males are more frequent, for which reason this population requires an adequate examination



tion of the teriparatide, 22 (7.9%) subjects developed new vertebral fractures (11.7% of those initially treated with placebo, 5.4% of those treated with 20 mcg/day of teriparatide and 6.0% of those previously treated with 40 mcg/day, reduction of risk of those of those treated with teriparatide of 51%, $P = 0.07$). The reduction in the incidence of moderate or severe vertebral fractures in those treated with teriparatide considered as a single group was significant (reduction in relative risk 83%, reduction in absolute risk 5.7%; $p = 0.01$). The analysis of those subjects with previous vertebral fractures at the start of the study ($n = 114$) showed a reduction in absolute risk of new fractures in those treated with teriparatide of 13.1%, with a notable absence of moderate or severe fractures in these subjects ($P = 0.002$ vs placebo). There were no differences in non-vertebral fractures. Neither were there any safety problems among those patients previously treated with teriparatide. The authors conclude that the anti-fractural efficacy of teriparatide in males is similar to that in women.

Another study analysed the effect of teriparatide after suspending the recommended treatment during 18 to 24 months with teriparatide⁴³. They studied 21 subjects up to 2 years after the withdrawal of treatment with teriparatide. This study has 2 phases, one in which out of 24 subjects who were randomly chosen for treatment with teriparatide or placebo over 18 months⁴¹, 22 accepted participation in an extension. Those who received the placebo were treated subsequently with teriparatide over 18 months ($n = 11$), while those receiving TRTP in the original study ($n = 11$) received an additional year of treatment (the total duration of treatment with teriparatide being 30 months). At the end of this period, of 21 who continued and who were offered continued treatment with a BP, and Ca and vitamin D, 12 subjects accepted (57%; 10 of those with ALN), whilst 9 (43%) initially declined the offer, although 6 of those (67%) finally agreed to take it,

2 after 6 months of halting the teriparatide and 4 after a year. Therefore, a year after halting the teriparatide 7 subjects had received neither BF nor any other active medication against osteoporosis save calcium and vitamin D, and 11 had received BF and, even if it was not a randomised study, both groups were similar in terms of age, BMI, duration of treatment with teriparatide, BMD and change in BMD after teriparatide.

After a year of follow up the group treated with BF increased their lumbar BMD by an additional 5.1%, while those who did not take medication lost 3.7% ($P < 0.002$). The 6 subjects who continued treatment with BF for a second year (but not during the first) increased their BMD by 2.6%, although this increase was less than that observed at the end of treatment with teriparatide. Those subjects who started treatment with BF after the end of the teriparatide obtained an additional increase in BMD after 2 years of follow up of 8.9%. Thus, the total increase over the 4 years of the study was 23% for those treated for 2 years with teriparatide and subsequently for 2 years with BF, as opposed to 11.1% in those treated for 2 years with teriparatide followed by 1 year without treatment and another year with BF. The 3 subjects who only received teriparatide showed an increase after 4 years of 5.5%. Despite the limitations of the study (not randomised nor controlled with placebo, low number of cases...), this study suggests that the immediate use of BF after the withdrawal of teriparatide may optimise the increase in lumbar BMD, and that this therapeutic scheme results in a higher increase in BMD than concomitant treatment with teriparatide or PTH and BF.

In conclusion, teriparatide produces an increase in BMD in the lumbar spinal column, in the femur and total body in males with idiopathic OP and increases, dose-dependently, the concentrations of markers for bone formation and resorption. The

non-controlled follow up of patients who previously received teriparatide and treated according to usual clinical practise, suggests in post-hoc analysis, the permanence of the effect of teriparatide up to 30 months after its withdrawal and a lower prevalence of vertebral fractures among those who had a previous vertebral fracture, especially moderate and severe. Non-controlled studies also suggest that the immediate use of BF at the end of treatment with teriparatide is advisable with the aim of maintaining or increasing BMD.

Teriparatide is the only specifically bone-forming drug approved in Spain for the treatment of OP in males.

A possible protocol for the intervention in the treatment of male OP is represented in Figure 1⁴⁴.

Conclusions for the treatment of OP in males

- According to clinical guides and the experts, the drug of choice in the treatment of male osteoporosis is risedronate. Cases of osteoporosis with high risk of fracture or where there is an intolerance or contraindication to treatment with bisphosphonate would indicate the use of teriparatide, as well as in cases where there is a high risk of fracture.

- For the same reasons as in the case of women, the administration of calcium and vitamin D to all patients is advisable.

- When hypercalciuria is detected the use of a thiazide (Grade C) can be considered.

- Androgens are only justified if there is clinical hypogonadism. Even in this case, they should probably be associated with aminobisphosphonates or teriparatide if the risk of fracture is very high despite androgenic substitution.

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