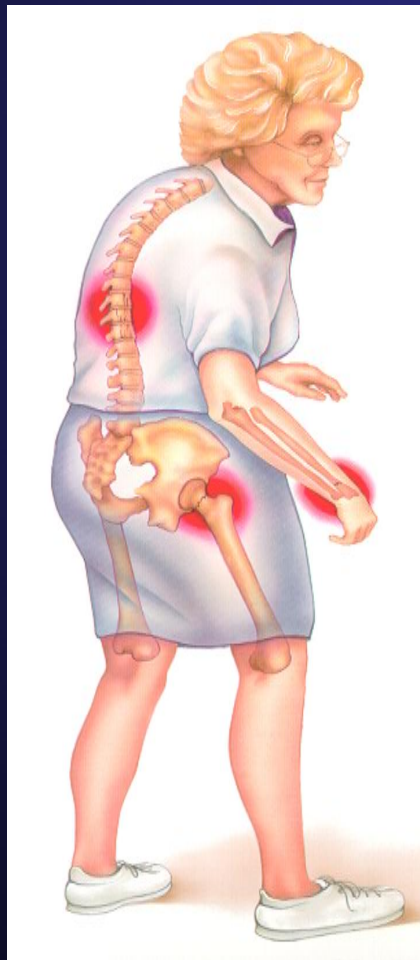


Bone Densitometry: a Key Tool for Osteoporosis Diagnosis and Monitoring during Treatments.



**From Pathology to
Diagnosis and
Rehabilitation
aiming to Health,
Functioning and
Authonomy .**

**Alfredo Romeo &
Alessandro Giustini**

Bone Turnover

- The mature bone is constantly renewed to maintain the mechanical integrity of the skeleton and to repair microcracks
- The metabolic process that affects the cortical and trabecular bone formed is called “remodeling”

BONE TURNOVER

Balance :Health

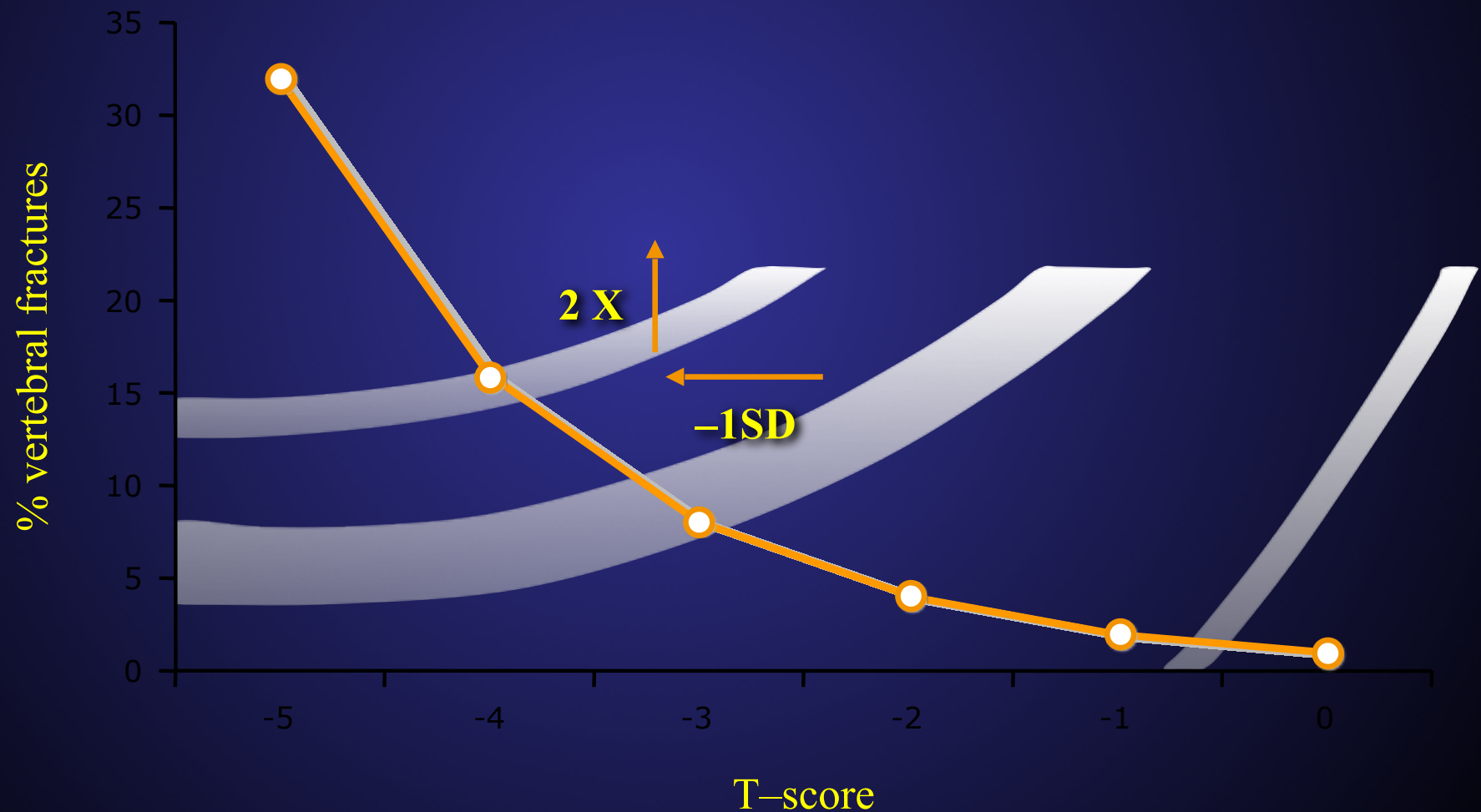
IMBALANCE: REABSORPTION

"A disease characterized by low bone mass and micro-architectural deterioration of bone tissue, leading to enhanced bone fragility and a consequent increase in fracture risk."



WHO definition, 1994,
the first time osteoporosis had a clinical definition

BMD is a good indicator of the increased risk of fractures

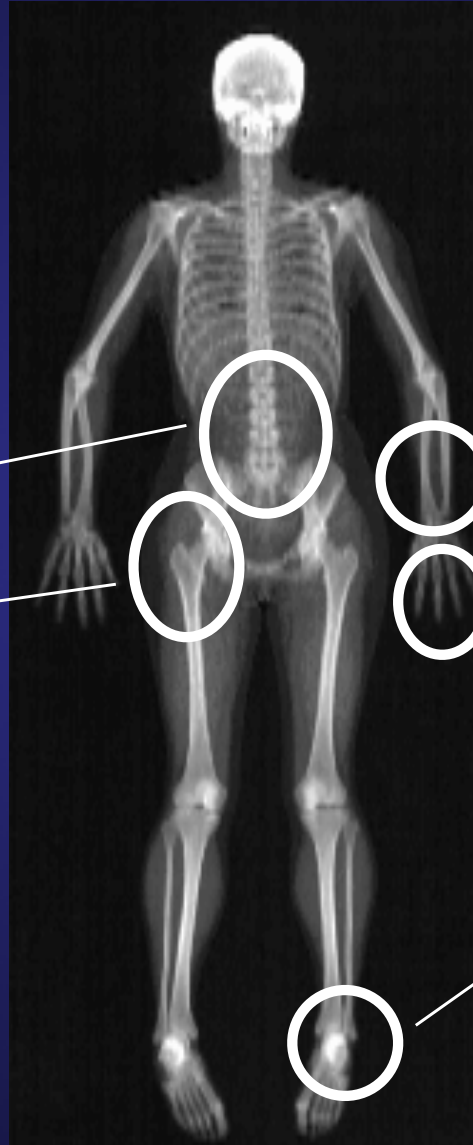


Bone densitometry study

Central Sites

Spine

Femur



Peripheral Sites

Forearm

Searches

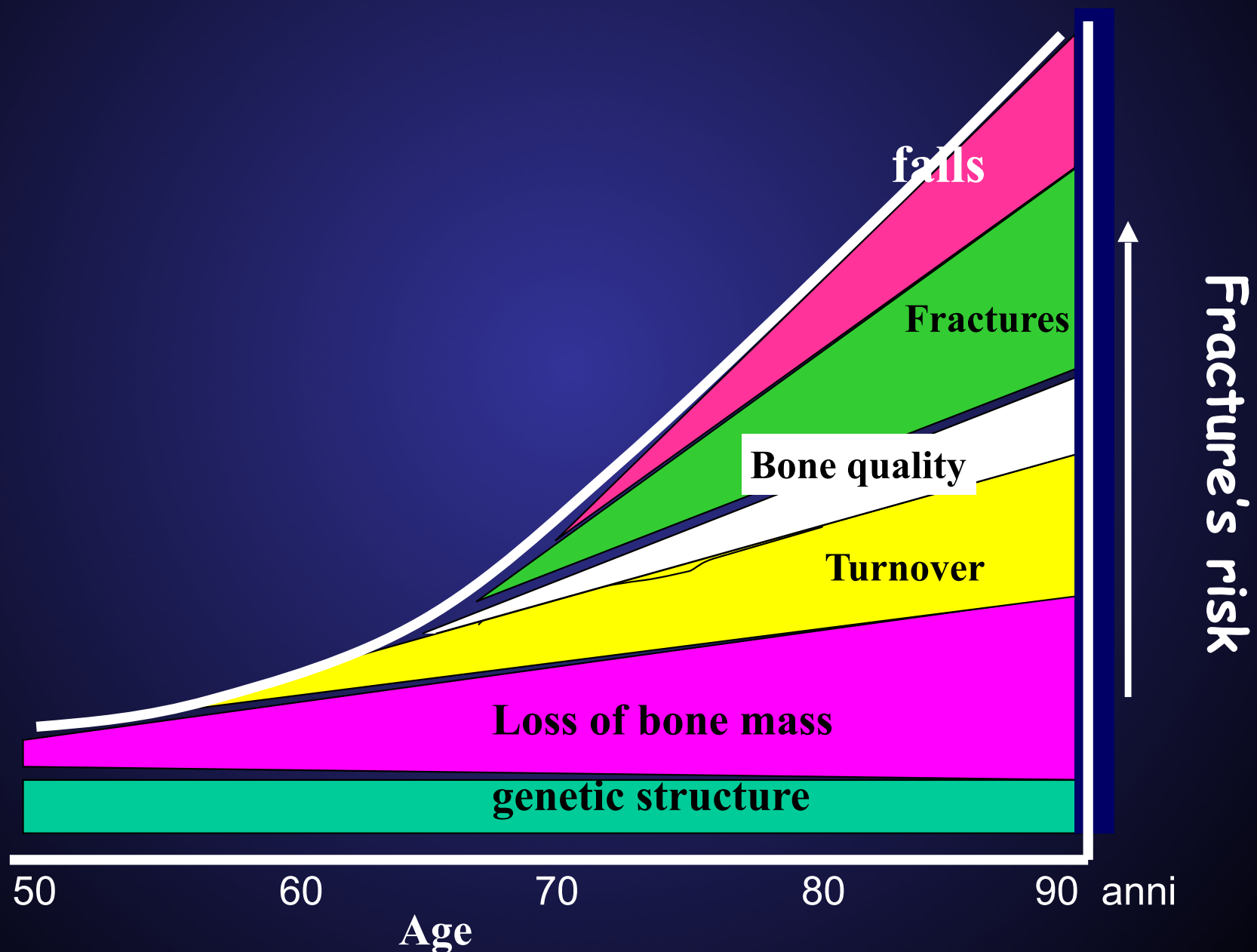
Calcagno

SOURCES OF ERROR IN THE DIAGNOSIS OF OSTEOPOROSIS BY DUAL X-RAY ABSORPTIOMETRY

Incorrect diagnosis of osteoporosis caused by:

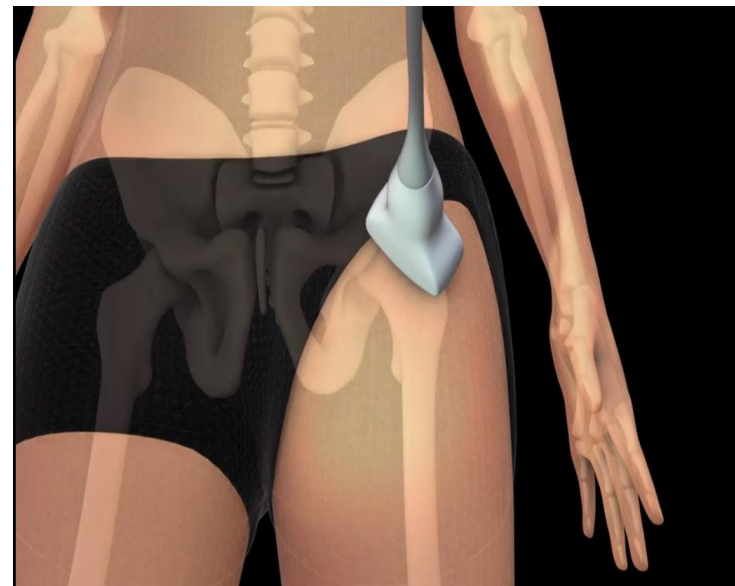
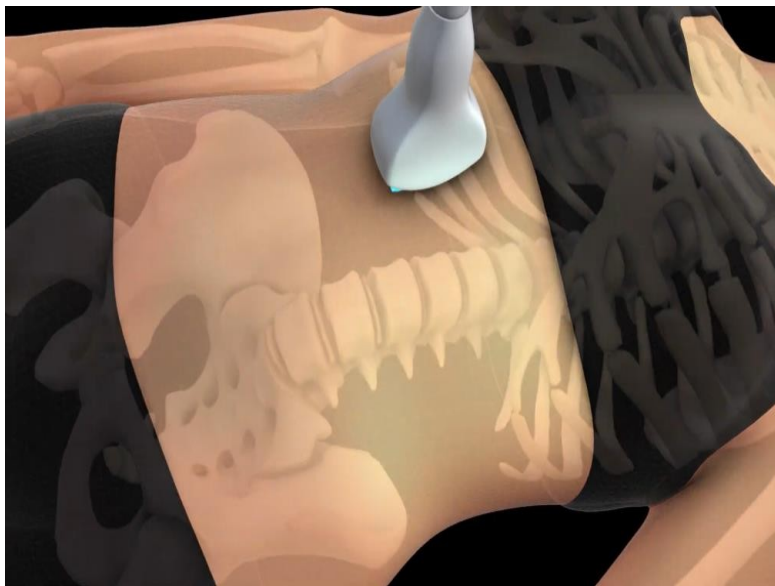
- **Osteomalacia**
- **Osteoarthritis (of spine but also of the hip)**
- **Soft tissue calcification (especially aortic calcification for spine measurements)**
- **Overlying metal objects**
- **Contrast media**
- **Previous fracture (spine, hip, and wrist)**
- **Severe scoliosis**
- **Extreme obesity or ascites**
- **Vertebral deformities due to osteoarthritis, Scheuermann's disease**
- **Inadequate reference ranges**
- **Inadequate operating procedure (calibration, region selection, positioning, acquisition mode)**

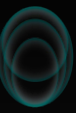
CUMULATIVE EFFECT OF INDEPENDENT RISK FACTORS SKELETAL AND EXTRASKELETAL FOR OSTEOPOROTIC FRACTURE



REMS technology: scanning mode

ULTRASOUND SCAN ON AXIAL ANATOMICAL SITES: LUMBAR VERTEBRAE AND PROXIMAL FEMUR

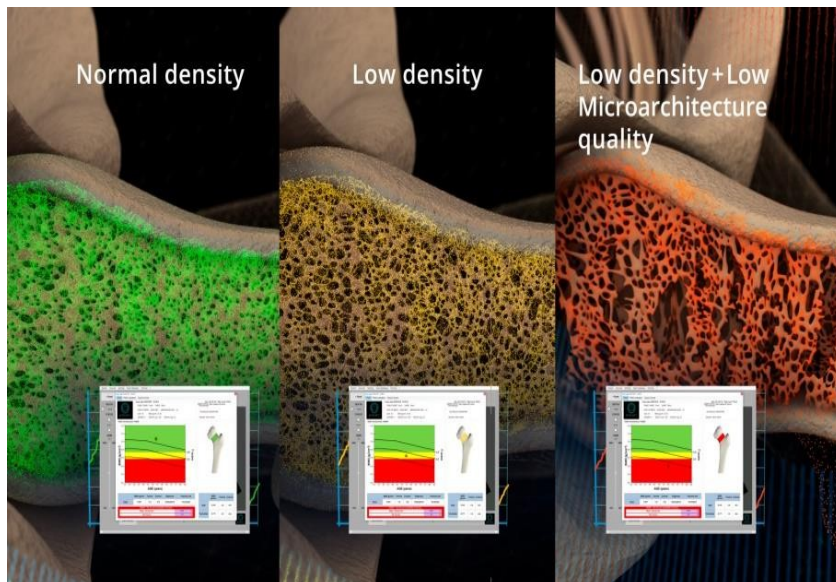




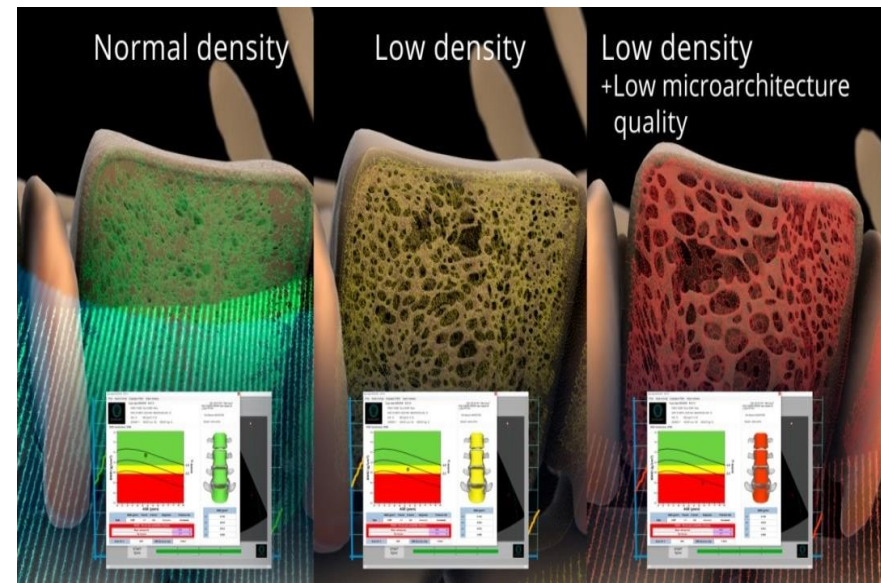
REMS technology: diagnostic classification

Diagnostic classification of the patient (**Normal**; **Osteopenic**; **Osteoporotic**)

FEMORAL NECK



LUMBAR VERTEBRAE



REMS technology: MINISTERIAL GUIDELINES

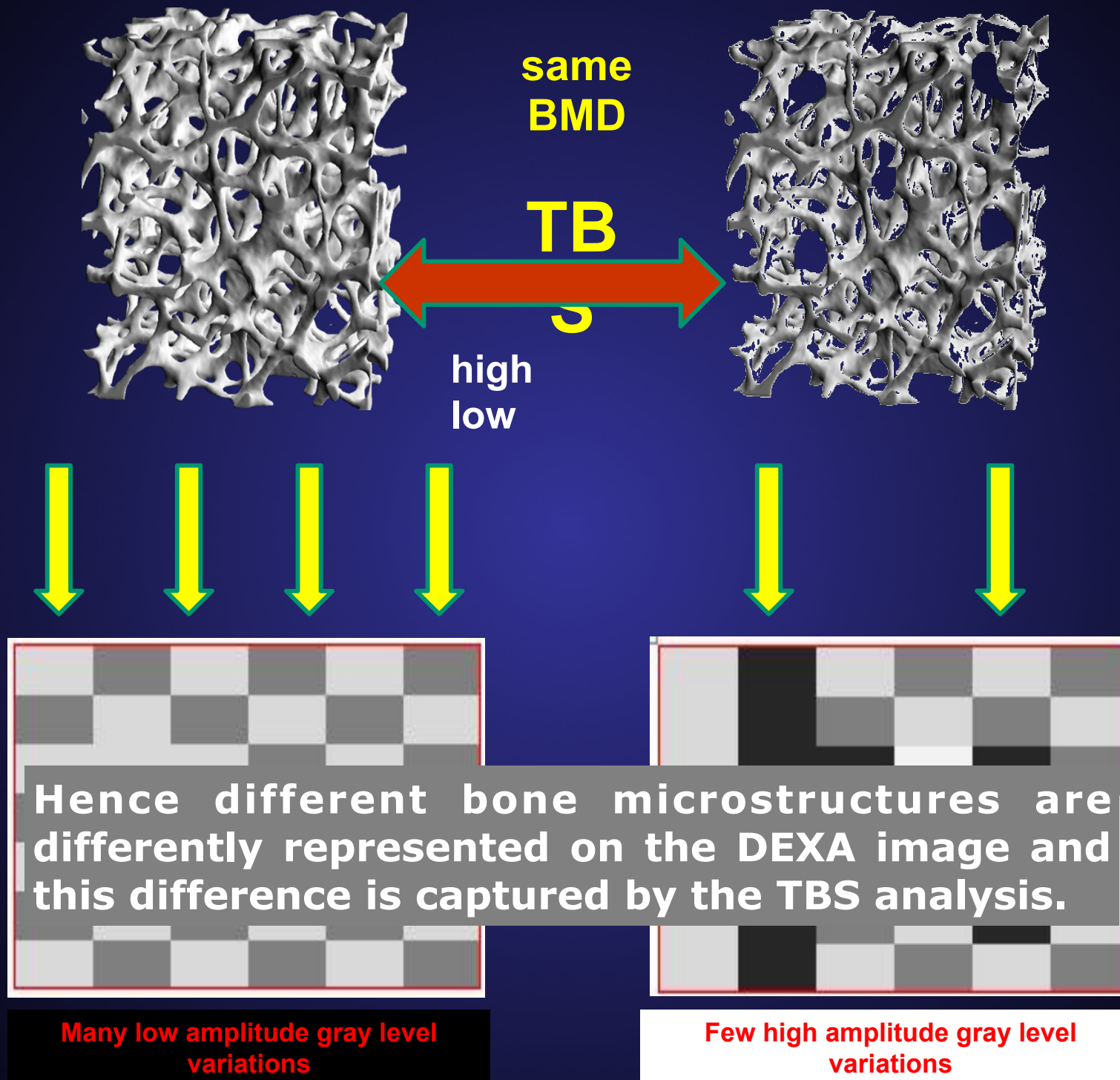
REMS ultrasound examination as a densitometric diagnostic element capable of facilitating the patient's care journey

- It has a good level of accuracy and precision
- It is an excellent predictor of the risk of fragility fracture
- It can improve the diagnosis of osteoporosis in the clinical routine
- It measures bone mineral density and is useful for patient monitoring
- It can be performed on all patients, including young, bedridden, pregnant women, etc.
- It is also recommended for patients hospitalized for Fragility Fractures, such as
 - femur, for which performing a diagnostic test could be complicated and yes
 - requires continuous densitometric evaluation.

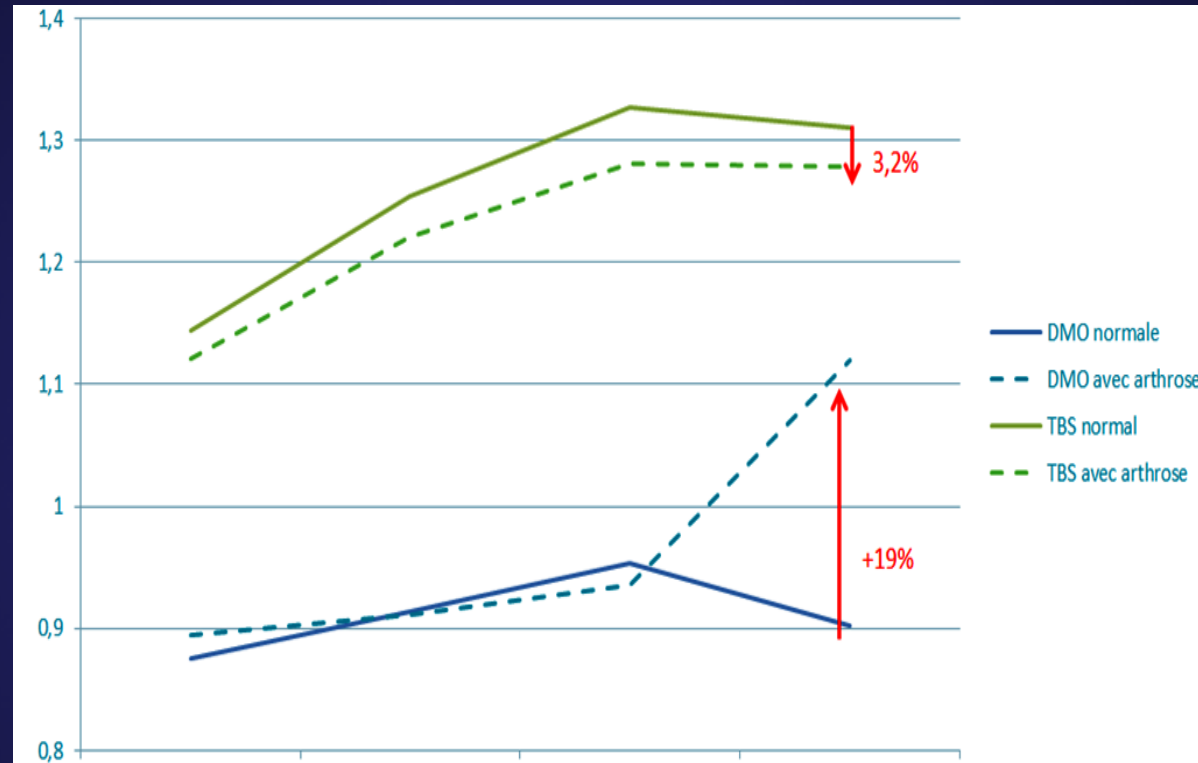


Definition of TBS

- The trabecular bone score (TBS) is a new measurement of tissue gray level that relies on the analysis of two-dimensionally projected images.
- The TBS is derived from the evaluation of the experimental variogram obtained from the gray scale of the DEXA.
- TBS is capable of differentiating three-dimensional microarchitectures that present different trabecular characteristics, regardless of bone mass.



Unlike BMD, TBS is little influenced by the presence of osteophytes (ARTHRISIS).



[Osteoporosis International](#)

November 2013, Volume 24, [Issue 11](#), pp 2837–2846



Generation and validation of a normative, age-specific reference curve for lumbar spine trabecular bone score (TBS) in French women

Authors

R. Dufour, R. Winzenrieth , A. Heraud, D. Hans, N. Mehsen

TAKE AWAY

- Bone mineral density is a determinant of skeletal fragility
- The diagnosis of skeletal fragility is the integrated result of bone density and the presence of risk factors
- Densitometric follow-up of the patient should take into account the characteristics of the appliance and any pharmacological treatment in place
- The interpretation of the densitometric data in the follow-up is conditioned by the severity of the osteoporotic picture and the necessary clinical re-evaluation of the patient

TARGET TO
TREAT




TREAT TO
TARGET

Next

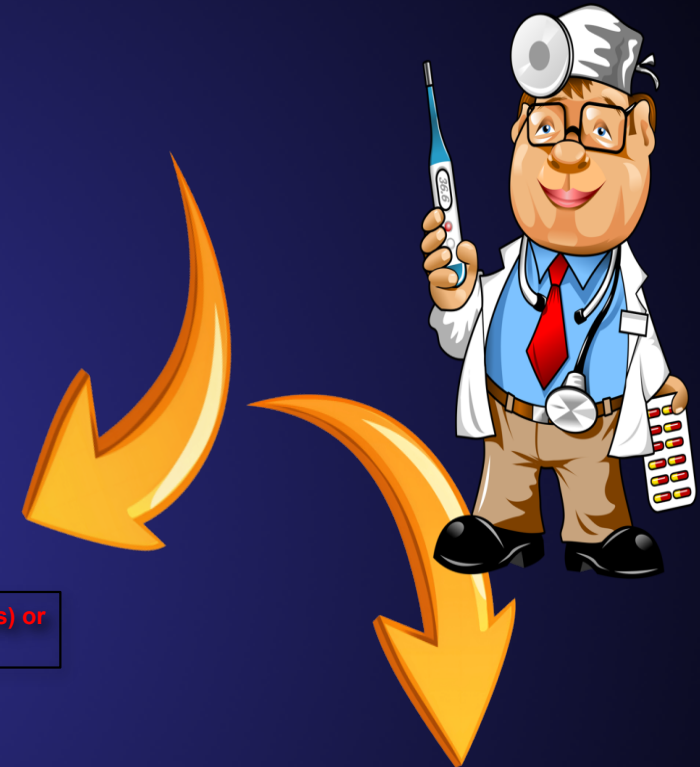
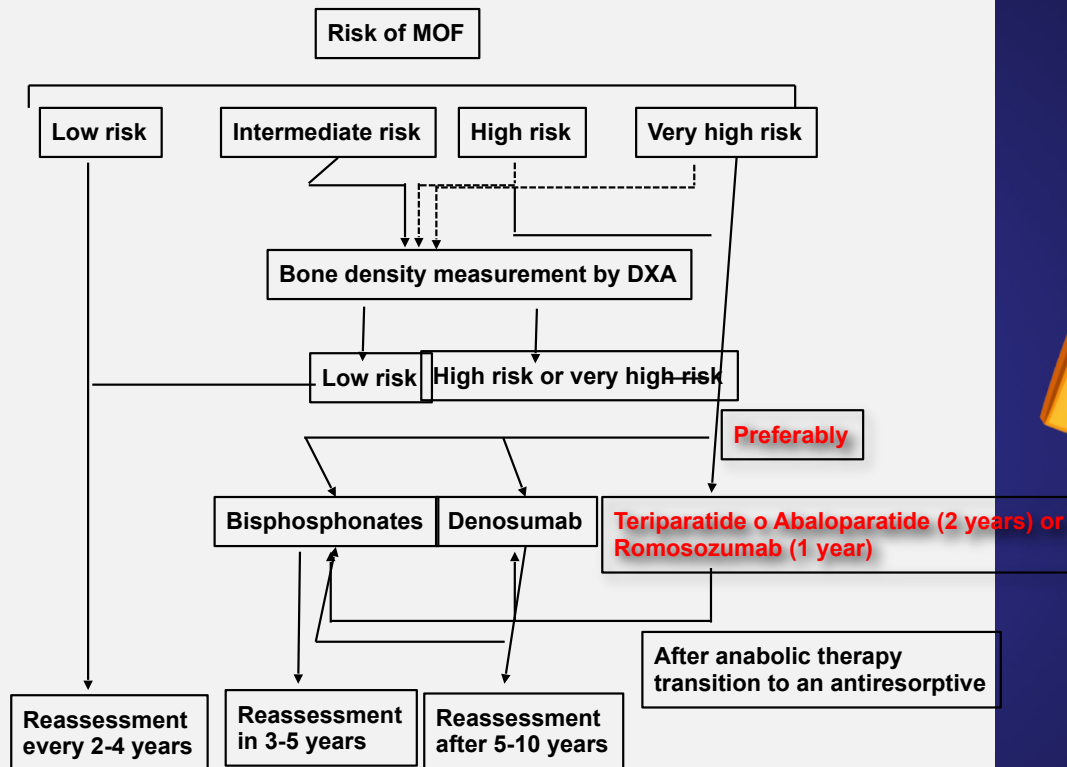
The whole
treatment



Long-term and sequential treatment for osteoporosis

Ines Foessel , Hans P. Dimai & Barbara Obermayer-Pietsch 

Evaluation of patients / people (risk fracture and other aspects)



Integration of
treatments
regarding times and
critical points

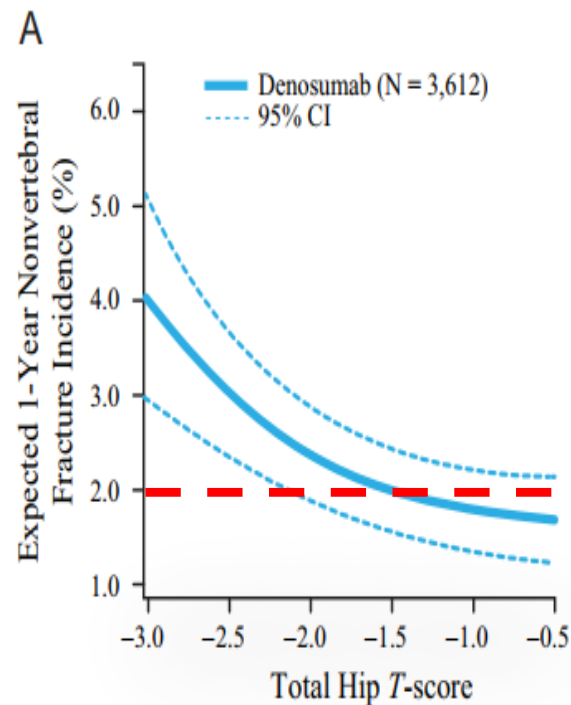
TARGET →
BMD > -2.5

Randomized Controlled Trial > J Bone Miner Res. 2019 Jun;34(6):1033-1040.

doi: 10.1002/jbmr.3722. Epub 2019 May 29.

Relationship Between Bone Mineral Density T-Score and Nonvertebral Fracture Risk Over 10 Years of Denosumab Treatment

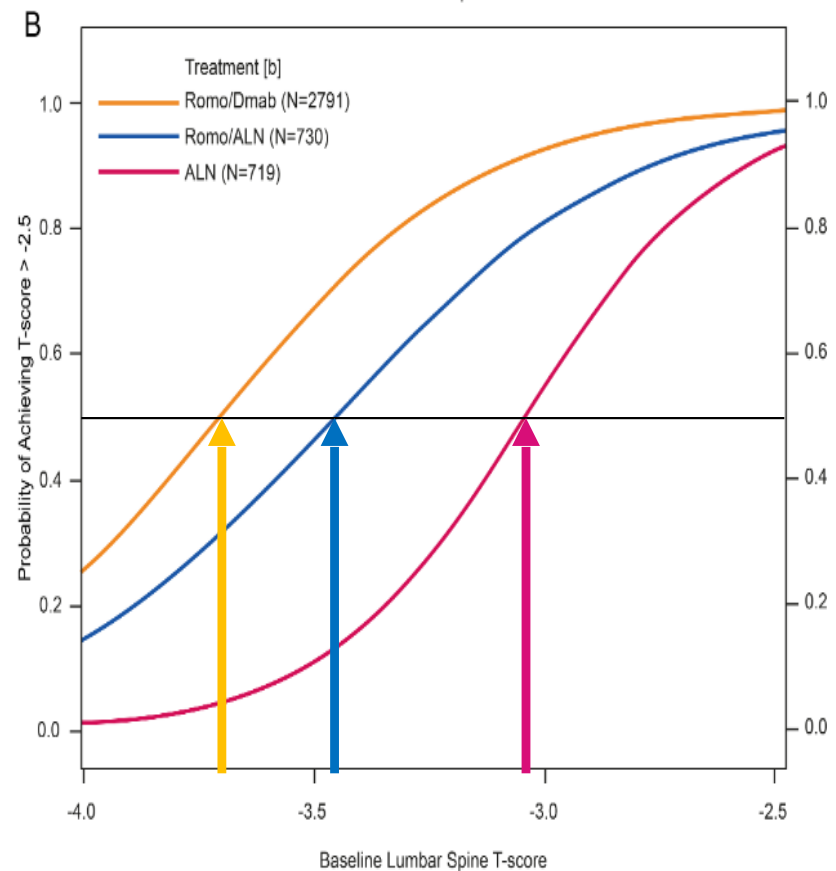
S Ferrari¹, C Libanati², Celia Jow Fang Lin³, J P Brown⁴, F Cosman⁵, E Czerwiński⁶, L H de Gregório⁷, J Malouf-Sierra⁸, J-Y Reginster⁹, A Wang³, R B Wagman³, E M Lewiecki¹⁰



> JBMR Plus. 2021 Oct 6;5(11):e10546. doi: 10.1002/jbmr.10546. eCollection 2021 Nov.

Romsozumab Followed by Antiresorptive Treatment Increases the Probability of Achieving Bone Mineral Density Treatment Goals

Felicia Cosman¹, Cesar Libanati², Cynthia Deignan³, Zhigang Yu³, Zhenxun Wang³, Serge Ferrari⁴, Jens-Erik Beck Jensen⁵, Pilar Peris⁶, Francesco Bertoldo⁷, Eric Lespessailles⁸, Eric Hesse⁹, Steven R Cummings¹⁰



> J Bone Miner Res. 2017 Feb;32(2):198-202. doi: 10.1002/jbmr.3051. Epub 2017 Jan 23.

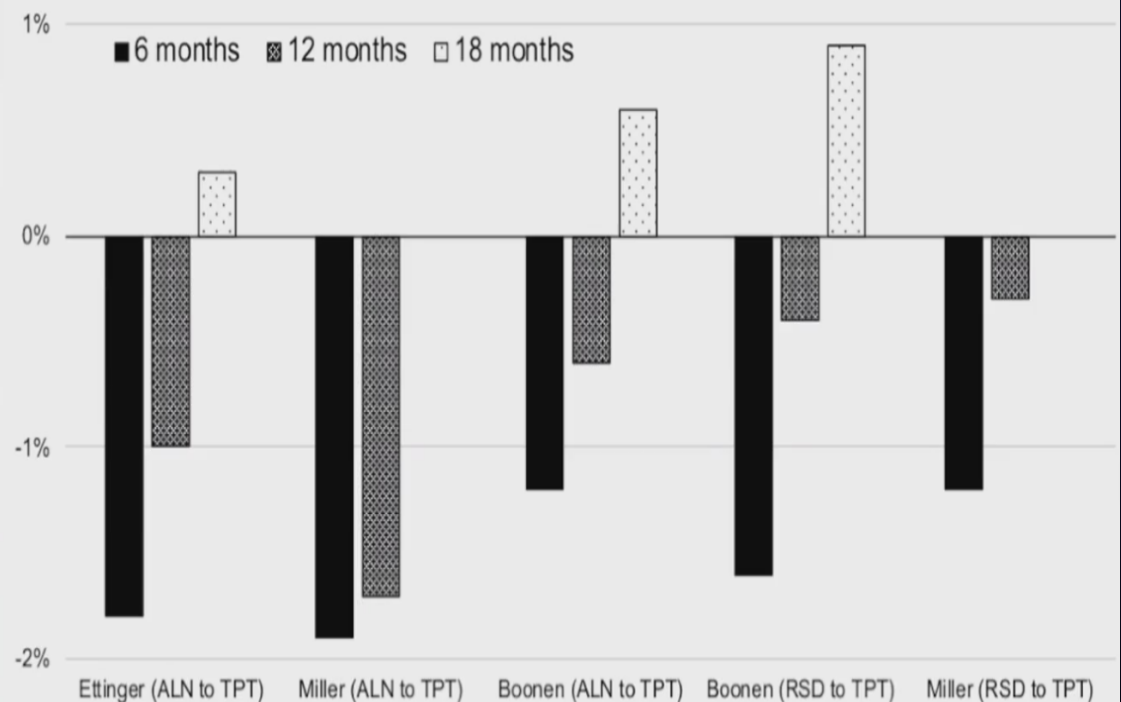
Treatment Sequence Matters: Anabolic and Antiresorptive Therapy for Osteoporosis

Felicia Cosman^{1 2}, Jeri W Nieves^{1 3}, David W Dempster^{1 4}

Antiabsorptive / Anabolic

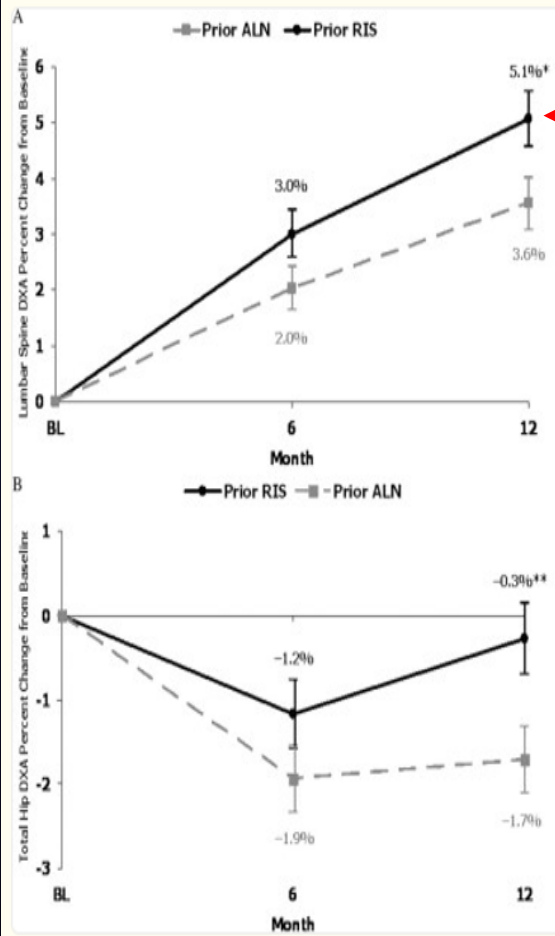
Switching from a bisphosphonate to teriparatide is initially disadvantageous, even though some recovery of bone mass occurs.

Hip BMD effect (% changes BMD after 6, 12 and 18 months of TPT) switching from potent anti-resorptive (RSD or ALN) to TPT



Early responsiveness of women with osteoporosis to teriparatide after therapy with alendronate or risedronate

Paul D Miller¹, Pierre D Delmas, Robert Lindsay, Nelson B Watts, Marjorie Luckey, Jonathan Adachi, Kenneth Saag, Susan L Greenspan, Ego Seeman, Steven Boonen, Suzanne Meeves, Thomas F Lang, John P Bilezikian;



Differential effects of teriparatide on BMD after treatment with raloxifene or alendronate

Bruce Ettinger¹, Javier San Martin, Gerald Crans, Imre Pavo

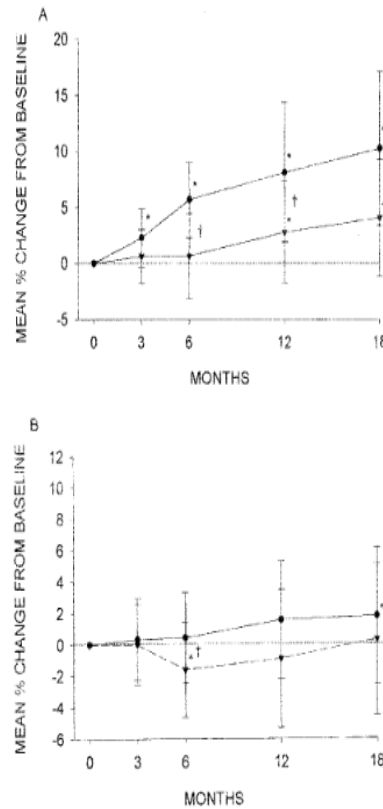
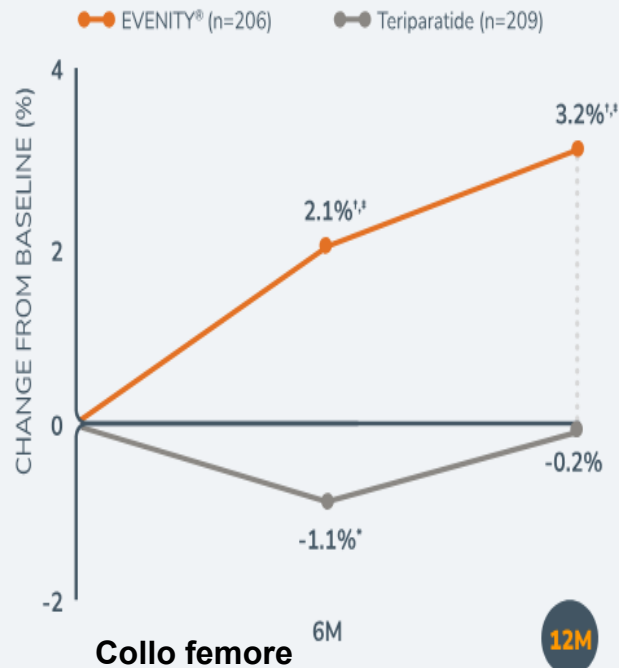
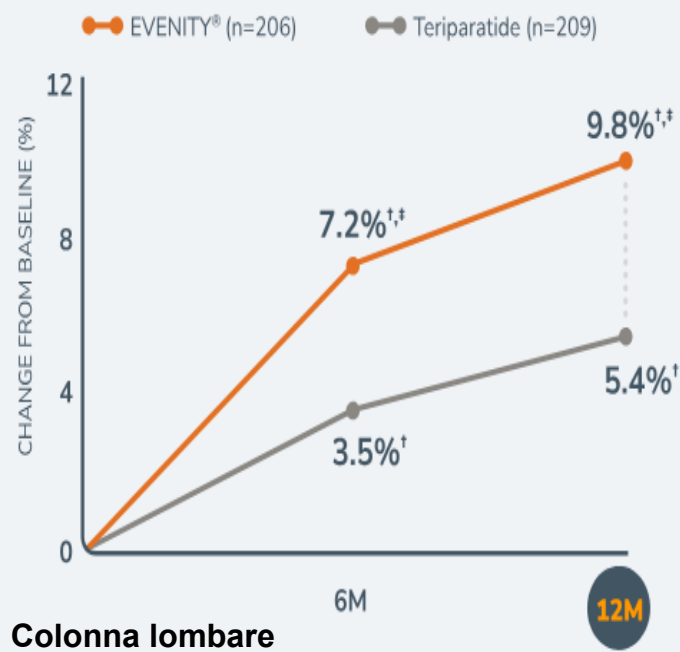
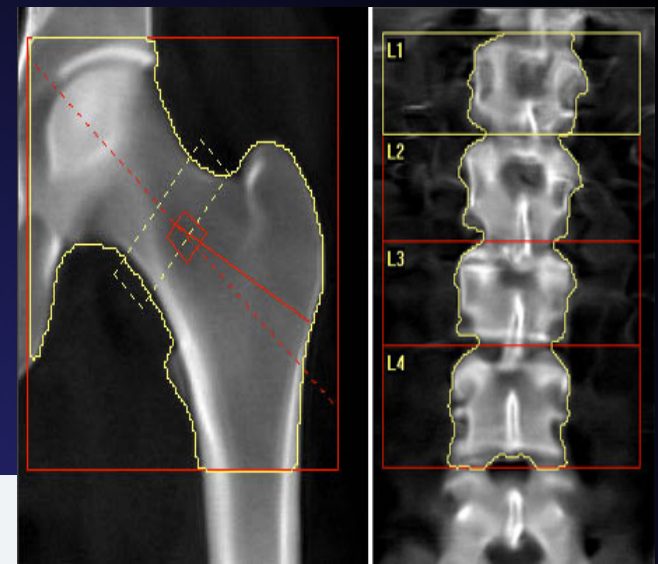


FIG. 3. Mean percent change in BMD from baseline for (A) lumbar spine and (B) total hip, by previous treatment with RLX or ALN. Prior RLX (●); prior ALN (▼). Error bars indicate \pm SD. * $p < 0.05$ change from baseline; † $p < 0.05$ difference between groups.



STRUCTURE: EVENITY® vs Teriparatide

Active-controlled BMD study of EVENITY® vs teriparatide in women with postmenopausal osteoporosis at high risk of fracture transitioning from oral bisphosphonates¹



Published in final edited form as:

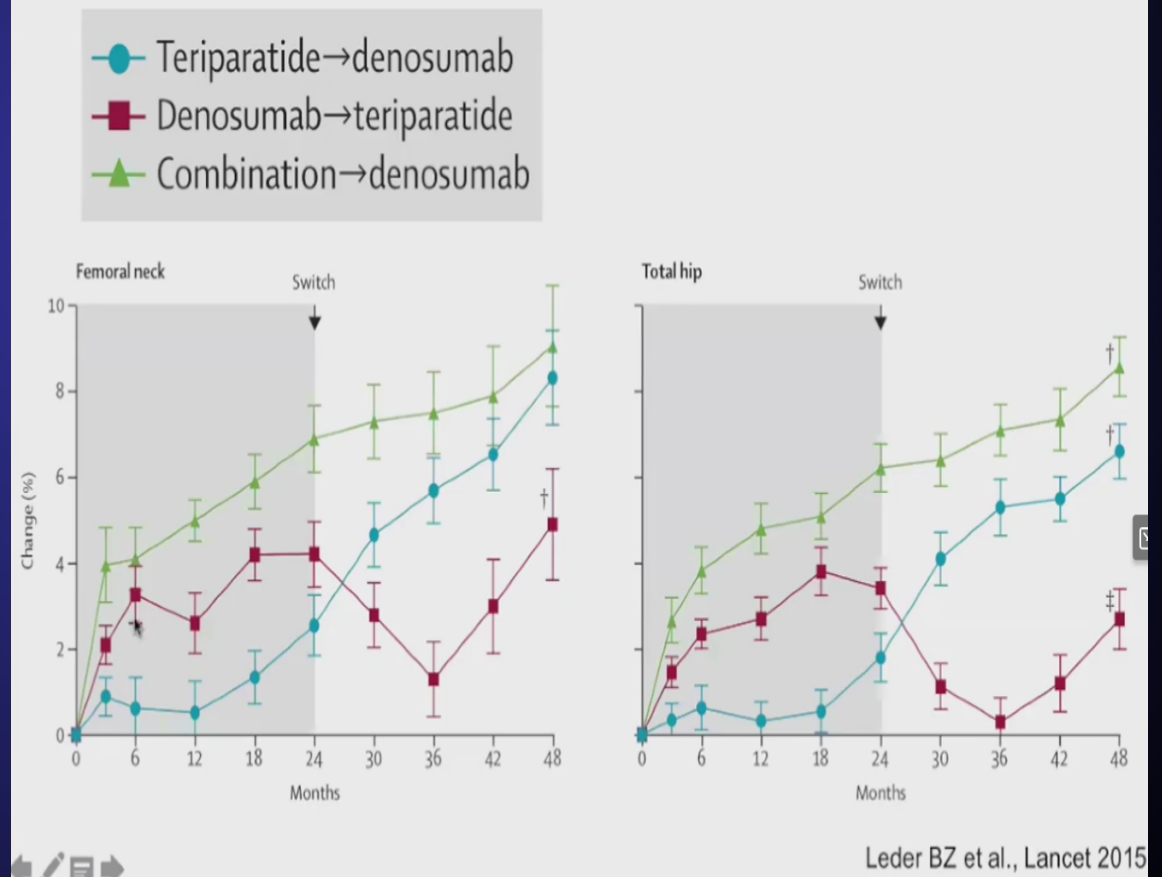
Lancet. 2015 September 19; 386(9999): 1147–1155. doi:10.1016/S0140-6736(15)61120-5.

Denosumab and Teriparatide Transitions in Postmenopausal Osteoporosis (The DATA-Switch Study): a Randomised Controlled Trial

Benjamin Z. Leder, MD, Joy N. Tsai, MD, Alexander V. Uihlein, MD, Paul Wallace, BA, Hang Lee, PhD, Robert M. Neer, MD, and Sherri-Ann M. Burnett-Bowie, MD

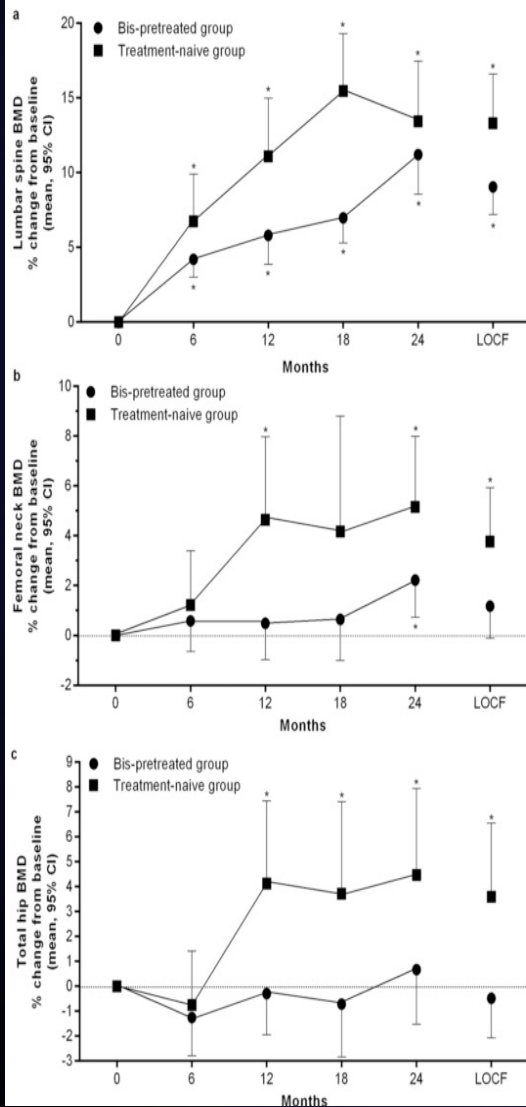
**NO with
DENOSUMAB**

Sequential therapy is not always appropriate and effective



Efficacy and safety of teriparatide in bisphosphonate-pretreated and treatment-naïve patients with osteoporosis at high risk of fracture: Post hoc analysis of a prospective observational study

Fumito Yoshiki¹, Atsushi Nishikawa², Masanori Taketsuna³, Kenta Kajimoto⁴, Hiroyuki Enomoto⁵

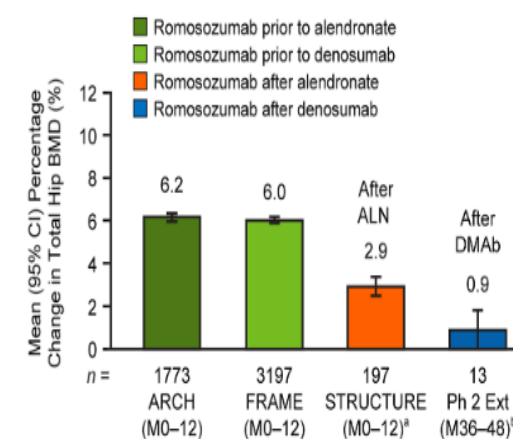


> Osteoporos Int. 2022 Jun;33(6):1243-1256. doi: 10.1007/s00198-021-06174-0. Epub 2022 Feb 15.

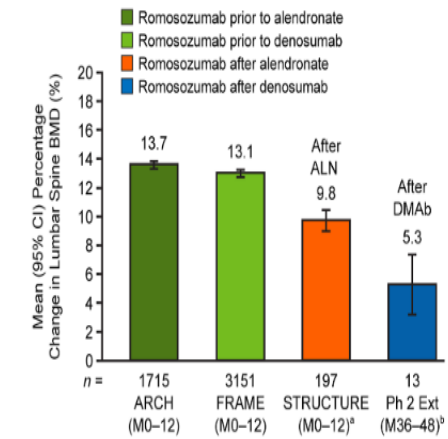
Romosozumab and antiresorptive treatment: the importance of treatment sequence

Felicia Cosman¹, David L Kendler², Bente L Langdahl³, Benjamin Z Leder⁴, E Michael Lewiecki⁵, Akimitsu Miyauchi⁶, Maria Rojeski⁷, Michele McDermott⁷, Mary K Oates⁷, Cassandra E Milmont⁷, Cesar Libanati⁸, Serge Ferrari⁹

a. 1 Year Gains With Romosozumab



c. 1 Year Gains With Romosozumab

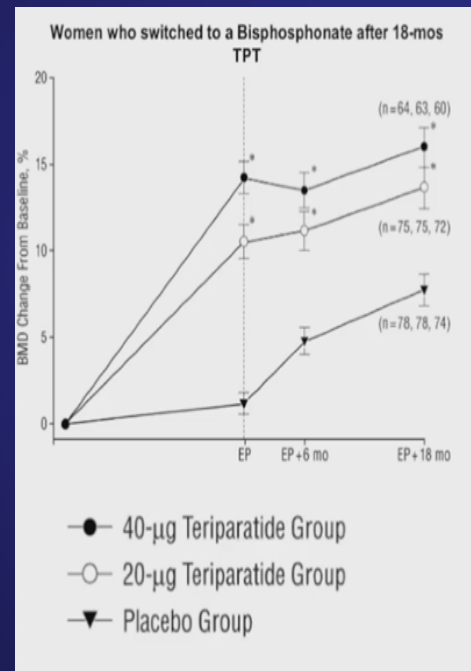
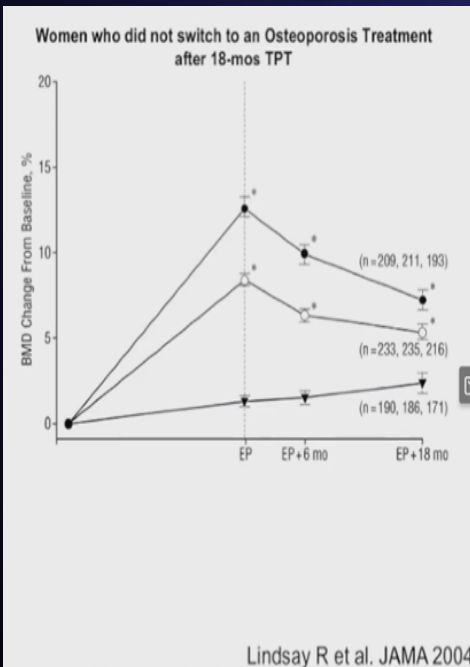


Sustained vertebral fracture risk reduction after withdrawal of teriparatide in postmenopausal women with osteoporosis

Robert Lindsay¹, Wim H Scheele, Robert Neer, Gerhardt Pohl, Silvano Adami, Carlos Mautalen, Jean-Yves Reginster, Jan J Stepan, Stephen L Myers, Bruce H Mitlak

After discontinuing teriparatide, BMD begins to decline until it returns to similar to that of untreated patients after two years.

Sequential therapy also in reverse sequence to maintain the acquired BM



Switching to antiresorptive therapy maintains BMD gains and even tends to improve them.

Efficacy of Switching From Teriparatide to Bisphosphonate or Denosumab: A Prospective, Randomized, Open-Label Trial

Rui Niimi¹, Toshibumi Kono¹, Atsushi Nishihara¹, Masahiro Hasegawa², Toshihiko Kono¹, Akihiro Sudo²

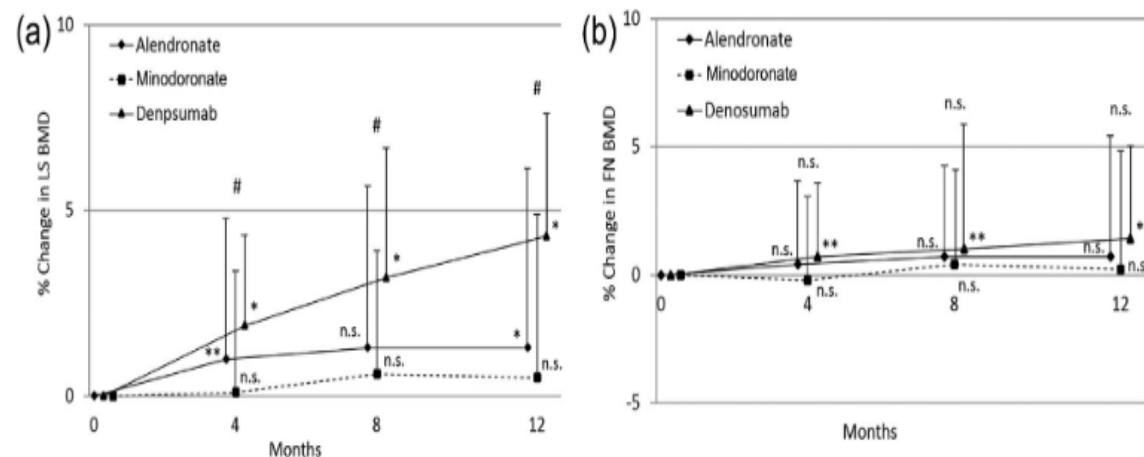
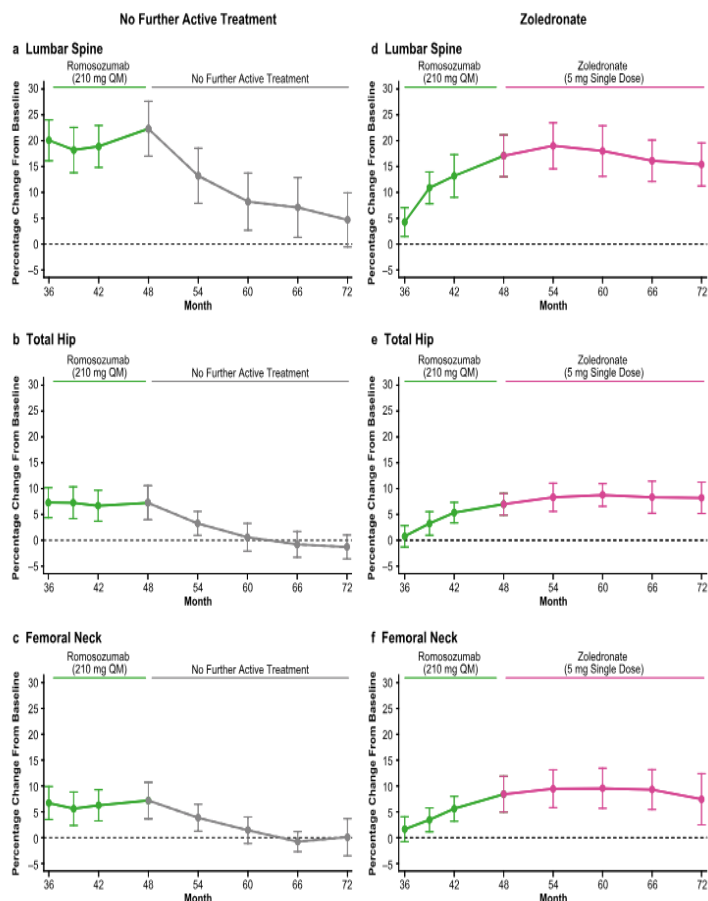


Fig. 2. Longitudinal changes in bone mineral density (BMD). Mean percent changes in (A) the lumbar spine (LS BMD) and (B) femoral neck bone mineral density (FN BMD) at 4, 8, and 12 months (* $p < 0.01$, ** $p < 0.05$, not significant [n.s.] versus baseline, paired t test; # $p < 0.01$ among three subgroups; Kruskal–Wallis test). Data are presented as means + standard deviations.



A single dose of zoledronate preserves bone mineral density for up to 2 years after a second course of romosozumab

M R McClung^{1,2}, M A Bolognese³, J P Brown⁴, J-Y Reginster^{5,6}, B L Langdahl⁷, J Maddox⁸, Y Shi⁸, M Rojeski⁸, P D Meisner⁹, A Grauer⁸

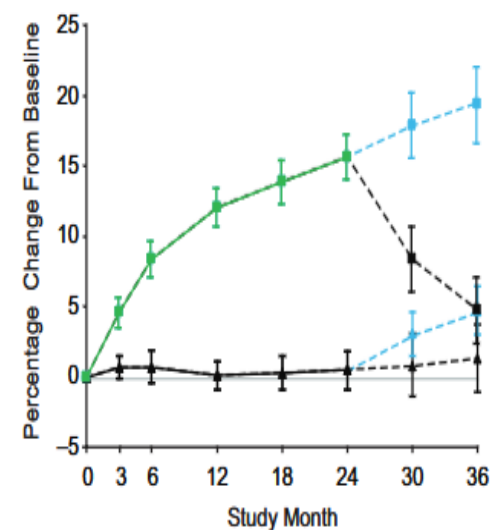


Effects of 24 Months of Treatment With Romosozumab Followed by 12 Months of Denosumab or Placebo in Postmenopausal Women With Low Bone Mineral Density: A Randomized, Double-Blind, Phase 2, Parallel Group Study

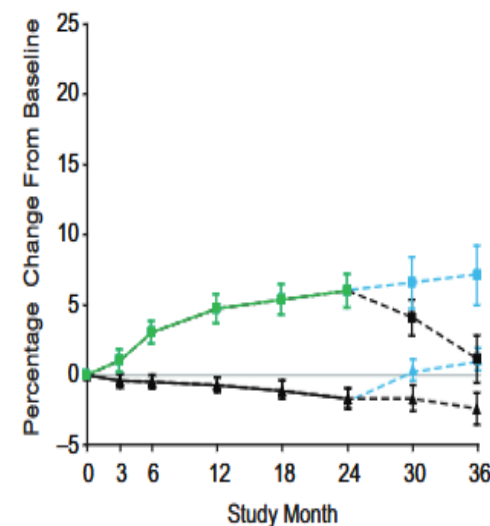
Michael R McClung^{1,2}, Jacques P Brown³, Adolfo Diez-Perez⁴, Heinrich Resch⁵, John Canalis⁶, Paul Meisner⁶, Michael A Bolognese⁷, Stefan Goemaere⁸, Henry G Bone⁹, Jose R Zanchetta¹⁰, Judy Maddox¹¹, Sarah Bray¹², Andreas Grauer¹¹

— Romosozumab 210 mg QM^a — Denosumab 60 mg Q6M^b
— Pooled Placebo^a — Placebo Q6M^b

A. Lumbar Spine

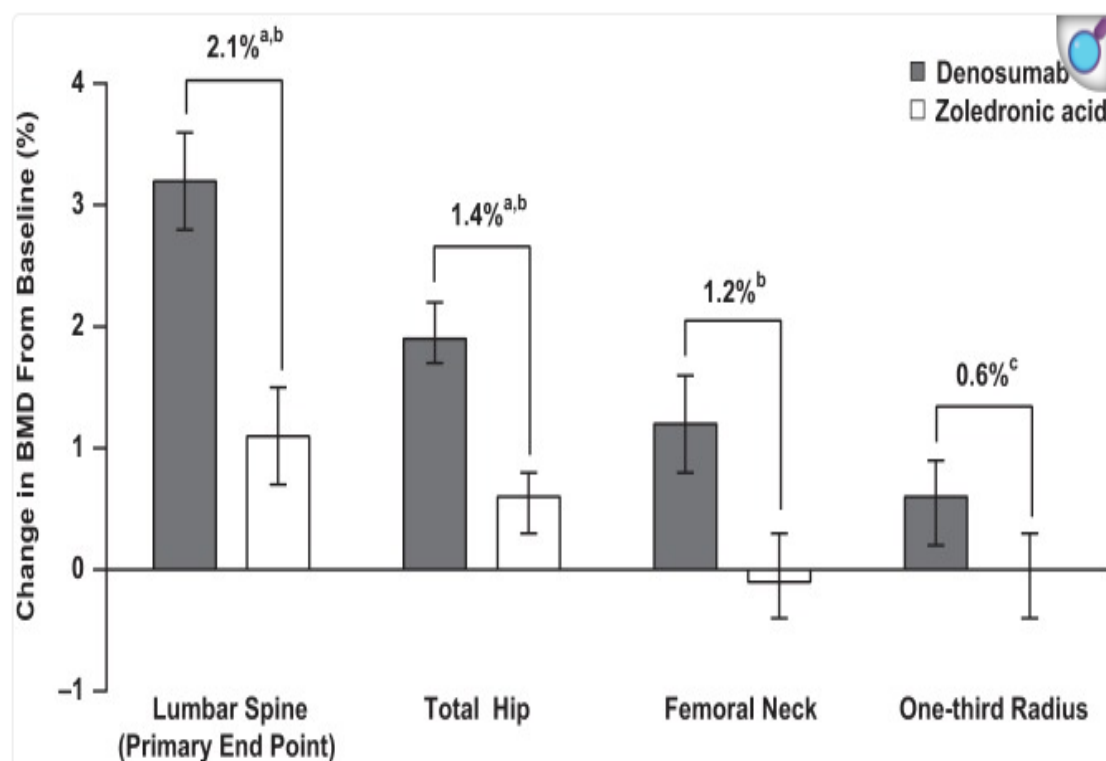


C. Total Hip



Denosumab or Zoledronic Acid in Postmenopausal Women With Osteoporosis Previously Treated With Oral Bisphosphonates

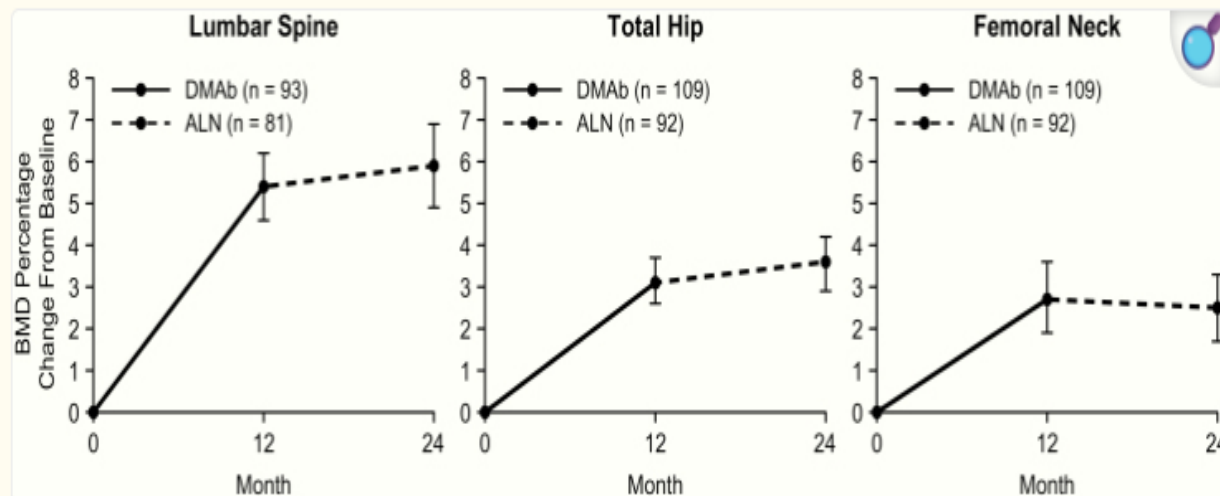
P D Miller¹, N Pannacciulli¹, J P Brown¹, E Czerwinski¹, B S Nedergaard¹, M A Bolognese¹, J Malouf¹, H G Bone¹, J-Y Reginster¹, A Singer¹, C Wang¹, R B Wagman¹, S R Cummings¹



Bone Mineral Density After Transitioning From Denosumab to Alendronate

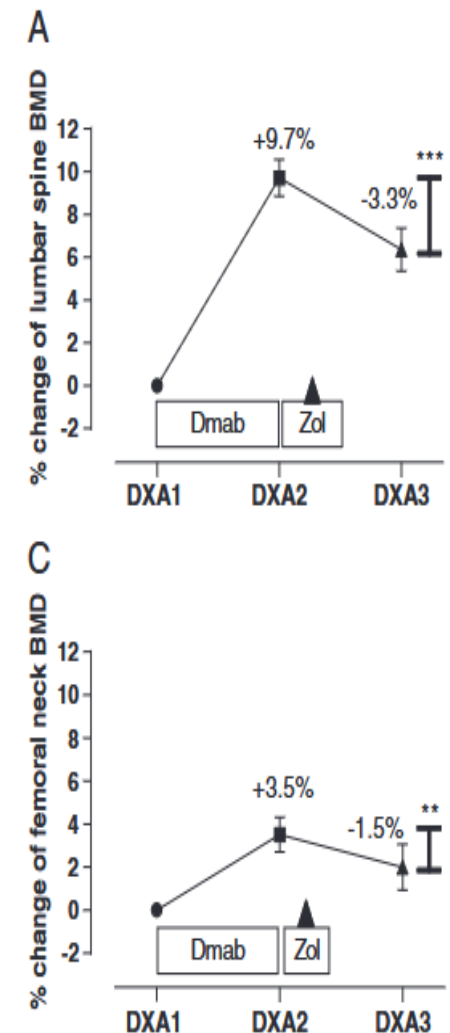
David Kendler¹, Arkadi Chines², Patricia Clark³, Peter R Ebeling⁴, Michael McClung^{5 6}, Yumie Rhee⁷, Shuang Huang², Robert Kees Stad⁸

Figure 1.



A Single Infusion of Zoledronate in Postmenopausal Women Following Denosumab Discontinuation Results in Partial Conservation of Bone Mass Gains

Judith Everts-Graber¹, Stephan Reichenbach^{2 3}, Hans Rudolf Ziswiler¹, Ueli Studer¹, Thomas Lehmann¹



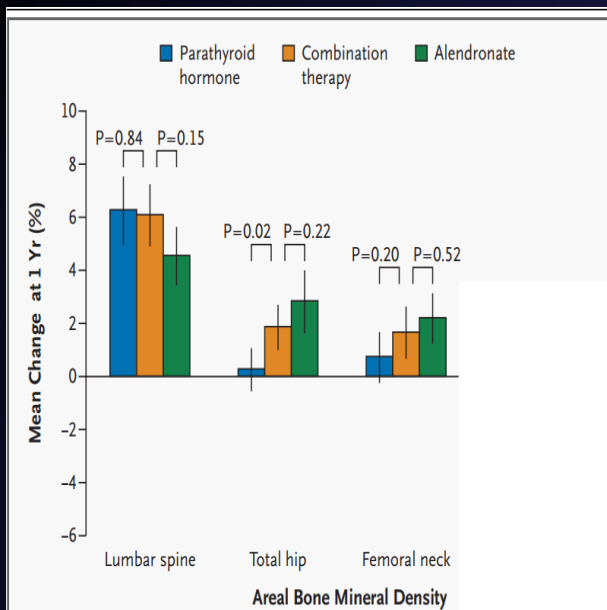


Figure 1. Mean Percent Changes in Areal Bone Mineral Density on Dual-Energy X-Ray Absorptiometry. The vertical lines represent the 95 percent confidence intervals. Negative changes represent decreases.

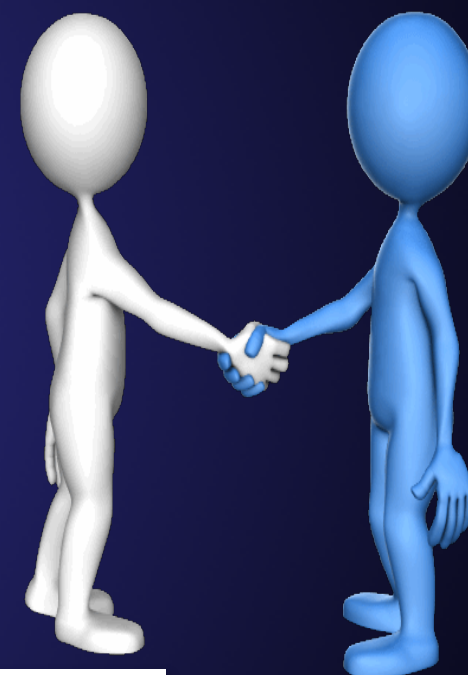
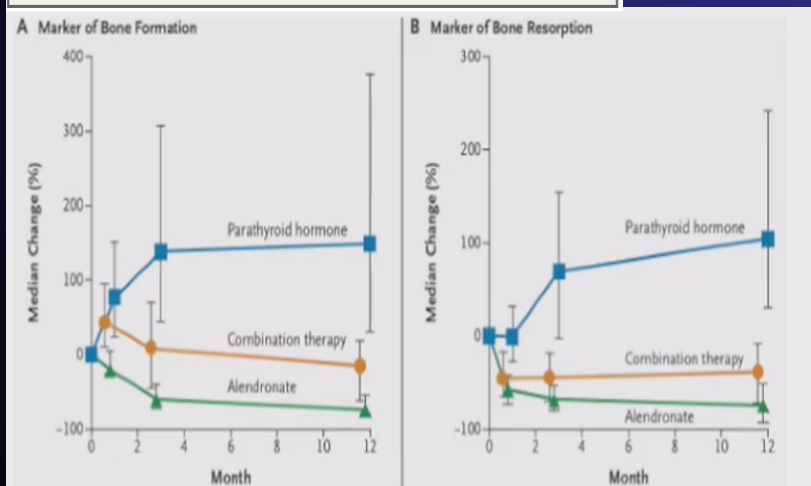
The NEW ENGLAND
JOURNAL of MEDICINE

ESTABLISHED IN 1812
SEPTEMBER 25, 2003
VOL. 349 NO. 13

The Effects of Parathyroid Hormone and Alendronate Alone or in Combination in Postmenopausal Osteoporosis

Dennis M. Black, Ph.D., Susan L. Greenspan, M.D., Kristine E. Ensrud, M.D., M.P.H., Lisa Palermo, M.A., Joan A. McGowan, Ph.D., Thomas F. Lang, Ph.D., Patrick Garnero, Ph.D., Mary L. Bouxsein, Ph.D., John P. Bilezikian, M.D., and Clifford J. Rosen, M.D., for the PaTH Study Investigators*

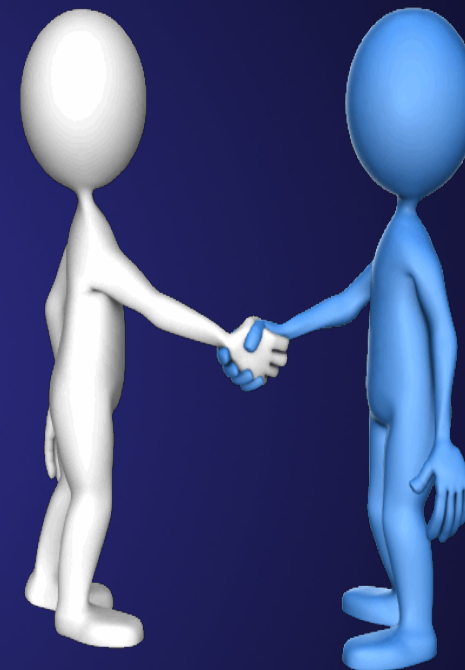
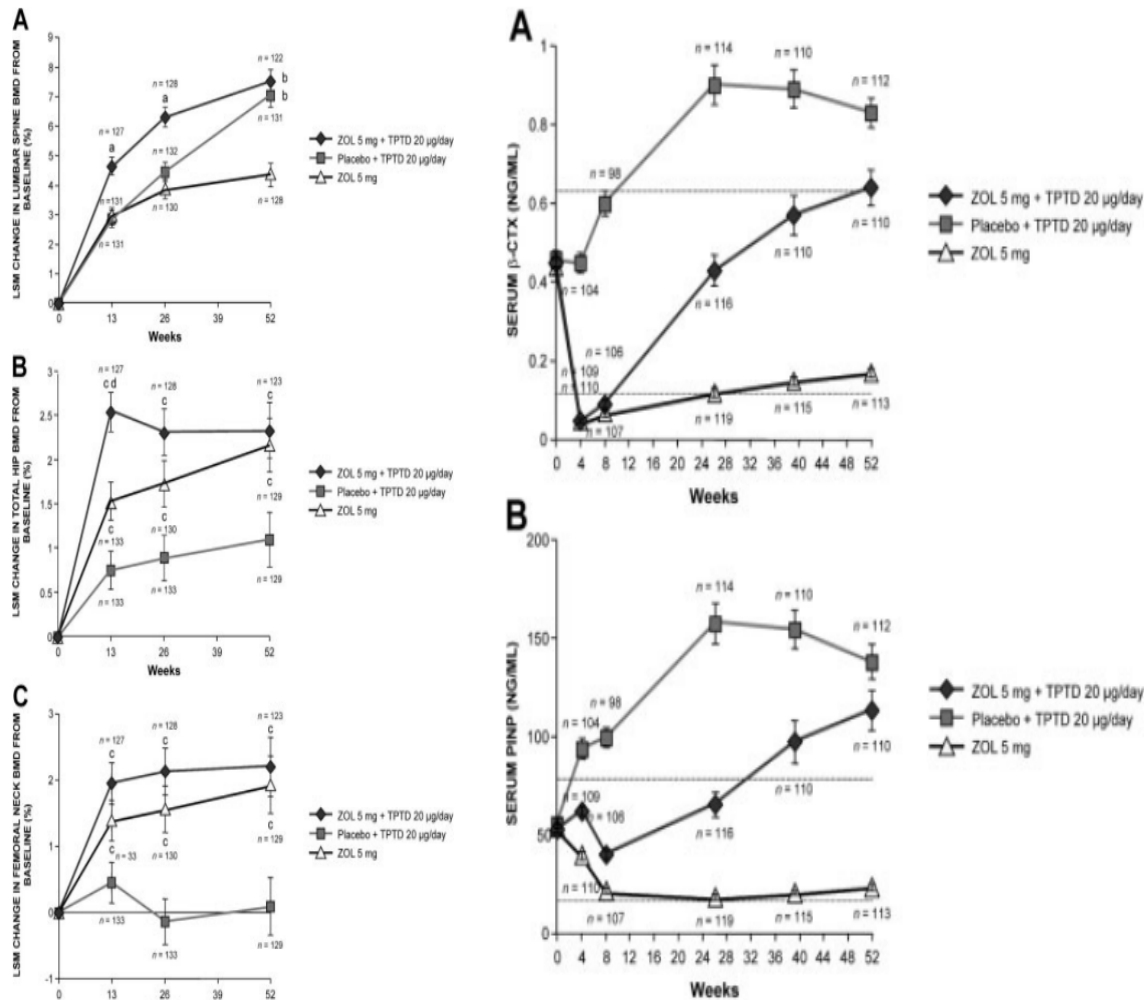
Alendronato + Teriparatide



Combined Therapy

Effects of intravenous zoledronic acid plus subcutaneous teriparatide [rhPTH(1-34)] in postmenopausal osteoporosis

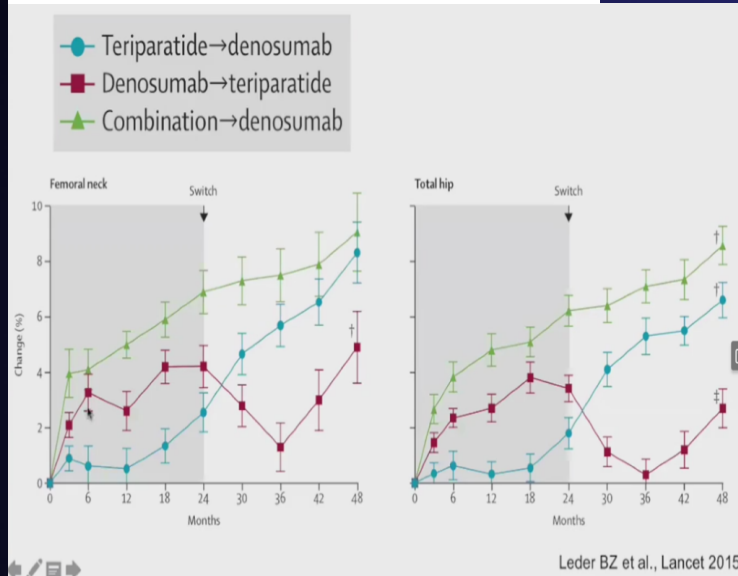
Felicia Cosman¹, Erik Fink Eriksen, Chris Recknor, Paul D Miller, Núria Guañabens, Christian Kasperk, Philemon Papanastasiou, Aimee Readie, Hanumantha Rao, Jürg A Gasser, Christina Bucci-Rechtweg, Steven Boonen



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Lancet. 2015 September 19; 386(9999): 1147–1155. doi:10.1016/S0140-6736(15)61120-5.

Denosumab and Teriparatide Transitions in Postmenopausal Osteoporosis (The DATA-Switch Study): a Randomised Controlled Trial

Benjamin Z. Leder, MD, Joy N. Tsai, MD, Alexander V. Uihlein, MD, Paul Wallace, BA, Hang Lee, PhD, Robert M. Neer, MD, and Sherri-Ann M. Burnett-Bowie, MD



Denosumab + Teriparatide

Lancet. 2013 July 6; 382(9886): 50–56. doi:10.1016/S0140-6736(13)60856-9.

Two Years of Denosumab and Teriparatide Administration in Postmenopausal Women With Osteoporosis (The DATA Extension Study): A Randomized Controlled Trial

Benjamin Z. Leder, Joy N. Tsai, Alexander V. Uihlein, Sherri-Ann M. Burnett-Bowie, Yuli Zhu, Katelyn Foley, Hang Lee, and Robert M. Neer

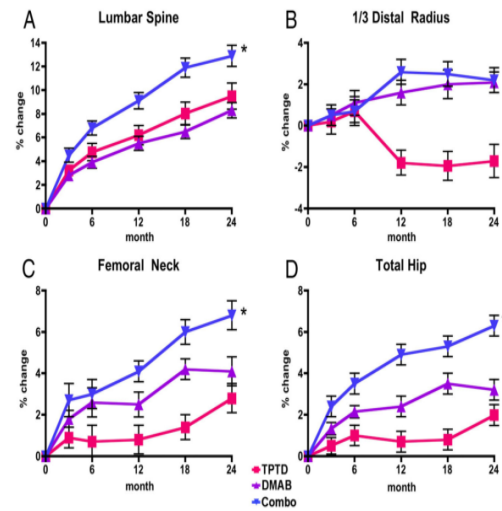


Figure 2. Mean percent change (SEM) in BMD from baseline to 24 months in the lumbar spine (A), one-third distal radius (B), femoral neck (C), and total hip (D) in the teriparatide (TPTD), denosumab (DMAB), and combination (Combo) groups. *, $P < .05$ compared with other groups.



A) Physical activity and B) Nutrition play a fundamental role in both the prevention and management of osteoporosis.

Here are the key aspects:

- A) Effects on bone density: • Stimulates the formation of new bone tissue • Slows age-related bone loss • Improves bone mineralization, especially in stressed bones • Other benefits: • Improves balance and coordination, reducing the risk of falls • Increases muscle strength • Improves posture • Reduces chronic pain.
- B) Calcium • It is the most abundant mineral in bones. • Daily requirement: o Adults: 1000 mg/day o Postmenopausal women and men >70 years: 1200 mg/day • Food sources: milk and dairy products, green leafy vegetables (cabbage, broccoli), fish with bones (sardines, anchovies), almonds, sesame seeds, calcium-rich mineral waters. Vitamin D • Essential for calcium absorption. • Requirement: 800-1000 IU/day (20-25 µg/day). • Sources: sun exposure (mainly), fatty fish (salmon, mackerel), eggs, fortified foods. • Supplementation is often necessary, especially in winter. Proteins • Constitutes 50% of bone volume and a third of bone mass. • Requirement: 1-1.2 g/kg of body weight/day in the elderly. • Important balance: neither deficiency nor Excess . Vitamin K • Important for bone mineralization • Sources: Green leafy vegetables, broccoli, cauliflower, vegetable oils. • Involved in bone matrix formation • Sources: Nuts, legumes, whole grains, green vegetables.

Nutritional Factors to Limit • Excess sodium: increases urinary calcium excretion • Excess caffeine: can reduce calcium absorption • Alcohol: interferes with calcium and vitamin D metabolism • Excess phosphorus: found in carbonated beverages and processed foods

Dietary Recommendations -1. Mediterranean diet: rich in fruits, vegetables, whole grains, fish, and olive oil -2. Regular consumption of dairy products (if tolerated) - 3. Adequate protein intake from various sources - 4. Limit salt and processed foods - 5. Stay hydrated with calcium-rich water - 6. Combine with physical activity (weight-bearing and resistance training).

When to Consider Supplementation ?

Supplementation may be necessary when: • Dietary intake is insufficient • Reduced intestinal absorption • Limited sun exposure (vitamin D) • In the presence of specific risk factors.

N.B. All these actions can be optimally conducted even remotely after adequate information and preparation of the person (TeleRehabilitation)

Rehabilitation (and physical activity) plays a fundamental role in managing this disease, not only with regard to reduced bone density and deterioration of bone microarchitecture, but also with regard to muscle mass and its functions, as well as the overall health of the individual, for treatment and prevention of falls and other issues.

Rehabilitation Goals

1. Fracture prevention - reduce the risk of falls and trauma
2. Improved bone density - stimulate mineralization
3. Pain reduction - manage associated chronic pain
4. Functional recovery - maintain independence in daily activities
5. Improved quality of life



It is needed a Personalized Rehabilitation Plan after a detailed evaluation of the Patient/Person

Physical Activity :

1. Weight-bearing exercises: • Brisk walking • Light jogging • Stair climbing • Dancing • Tennis
2. Resistance exercises: • Light weight lifting • Resistance bands • Gym machines • Free-body exercises
3. Balance exercises: • Tai chi • Yoga • Proprioceptive exercises
4. Flexibility exercises: • Gentle stretching • Joint mobility
5. Practical Recommendations Frequency and duration: • At least 30 minutes a day, 4-5 times a week • Combine different types of exercises
6. Precautions: • Avoid sudden movements or excessive twisting of the spine • Avoid high-impact exercises if osteoporosis is advanced • Be careful with forward flexion movements of the spine To Avoid: • Exercises that involve excessive flexion of the spine • Activities with a high risk of falling (if unsupervised) • Sudden movements or violent impacts if osteoporosis is severe

Patient Education • Correct body mechanics • Safe lifting techniques • Environmental modifications to prevent falls • Importance of calcium and vitamin D • Risk factor management .

Motor and balance exercises under the guidance of a physiotherapist.

Specific Physiotherapy • Manual therapy for joint mobility • Muscle relaxation techniques • Respiratory re-education (important for vertebral fractures) • Painful electrotherapy when necessary

Recommended frequency: 3-5 times per week, 30-60 minutes per session

Precautions : Avoid: • Sudden and high-impact movements • Excessive forward bending of the trunk • Forced twisting of the spine • Heavy lifting

Post-Fracture Rehabilitation In case of fracture (vertebral, femur, wrist):

1. Acute phase: pain control, early mobilization 2. Subacute phase: recovery of mobility, gradual muscle strengthening 3. Maintenance phase: long-term program to prevent recurrence

In conclusion

1. Currently, sequential therapy, on the basis of these evidences is a necessity in certain situations.
2. Combination therapy may be an option that needs to be carefully considered depending on the patient's condition and the medications we intend to use.



Regarding the evidence for Physical Activity and Rehabilitation, studies show that regular exercise programs can:

- Increase bone mineral density by 1-3%
- Reduce the risk of falls by 20-40%
- Significantly improve muscle strength and balance

From Pathology to Diagnosis and Rehabilitation aiming to Health, Functioning and Authonomy .

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