Surgical approach to fragility fractures: problems and perspectives

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ABSTRACT. The frequency of osteoporosis is constantly increasing all over the world. This pathology generates several problems, mostly due to fragility fractures, the worst consequence of impaired bone quality. Osteoporotic fractures often cause disability and loss of independence, partly because fracture fixation is not always easy and durable. So orthopedic surgeons need to learn and use new techniques to improve bone healing and surgical outcome, in order to grant fragility fracture patients a good quality of life. There are nails, screws and plates designed to maximize the bone-implant interface, substances which can be used locally to stimulate bone formation, and systemic therapies which can be used as adjuvants to decrease bone loss and/or enhance bone formation. Here, we report our personal experience, describing our surgical patients and their response to a bone-forming agent, such as teriparatide.

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INTRODUCTION

The concept of "fragility fracture" is of no little importance in the management of osteoporotic patients. The most important international societies, while developing guidelines for the diagnosis and treatment of osteoporosis, have indicated the presence of a fragility fracture as a fundamental criterion in identifying patients who urgently need to be treated. In 2002, the National Osteoporosis Foundation stated that "all individuals with a low-trauma fracture should be evaluated and, when indicated, treated for osteoporosis" (1). A World Health Organization (WHO) working group defined as "severe osteoporosis" the condition in which a T-score of <–2.5 is associated with a fragility fracture (2). How can a fragility fracture be identified? A first definition, given by the WHO in 1994 ("Assessment of fracture risk and its application to screening for postmenopausal osteoporosis") considered a fragility fracture as "a fracture caused by a trauma which would not fracture a normal bone: the result of an impaired compressive and/or torsional strength of bone". Clearly it is difficult, if not impossible, to establish if a trauma would have fractured even a normal bone. The American Academy of Orthopedic Surgeons ("Recommendations for Enhancing the Care of Patients with Fragility Fractures") in 2003 proposed a more clinical definition, considering a fragility fracture as a "fracture consequent to a fall from standing height or less" or a "fracture presenting in the absence of a clear trauma". In common clinical practice, it is necessary to evaluate the dynamics of the trauma, together with the patient's age and condition, and the presence of risk factors, in order to establish if a fracture may be due to osteoporosis. In 2005, a study was developed for 568 fractured patients with both minimal and moderate trauma fractures. Moderate trauma fractures were those due to sports traumas or falling down the stairs (less than ten steps). The most frequent fracture was that of the wrist (37%), independently of sex and traumatic mechanism, followed by fractures of the lower extremity (27%), with more ankle fractures in the minimal trauma group, and more diaphyseal fractures of the tibia and fibula in the moderate trauma group. The prevalence of previous fractures was greater in the moderate trauma group (54% women, 51% men) with respect to the minimal trauma group (50% and 45%). Particularly common, in moderate trauma women, were a fam-

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ily history of osteoporosis (50%, compared with 26% in the minimal trauma group), smoking, and early menopause (before the age of 45). Including moderate trauma subjects among the individuals at high fracture risk may increase the estimated incidence by 30% (3). The WHO considers as typical osteoporotic fractures those of the hip, wrist, proximal humerus, and clinical vertebral fractures (4). The World Orthopedic Osteoporosis Organization (WOOO) follows the WHO guidelines, but it considers the possibility of including the ankle among the main fracture sites (5).

TREATMENT OF FRAGILITY FRACTURES

Osteoporosis and surgery

The treatment of osteoporotic fractures tends to move toward surgery, with the use of implants which, through recomposition of the fragments or their prosthetic substitution, allow early mobilization of the patient. In elderly patients, surgery must lead to stability and a rehabilitation program must be rapidly started, in order to achieve acceptable functional recovery. Prolonged bed-rest or inadequate surgery increase the risk of thrombo-embolism, pulmonary and urinary complications, decubitus ulcers and musculoskeletal deterioration; all these conditions make it unlikely for complete recovery to be achieved, and they may be so severe that they can undermine life in a relatively short time. Patients are in the optimal condition to undergo surgical intervention in the first 48 hours after fracture (6). The procedure should be as simple as possible, with a short duration, careful manipulation of soft tissues, and minimal exposure of the fracture, in order to preserve blood supply and fracture hematoma, which may elicit bone callus formation. If the fracture is not intra-articular, it is better to prefer stability rather than anatomical reduction (7). The osteointegration of biomaterials which constitute bone implants and prostheses depends not only on the properties of the implant but also on the characteristics and regenerative potential of the host bone. As life expectancy is currently over 80 years, the majority of individuals "survive the quality of their connective tissue" (8), and there are many diseases typical of the elderly which may negatively affect surgical outcome. Osteoporosis is one of the most frequent. Surgical implants in osteoporotic bone may fail, due to changes in the mechanical and structural properties of bone and/or to imbalance between systemic and local factors (both anabolic and catabolic) which affect bone remodeling. The extent of the problem emerges from the evidence that surgery of meta-epiphyseal osteoporotic fractures fails in 50% of proximal humeral fractures, 25% of condylar femoral fractures, and 10% of trochanteric fractures (9, 10). It is necessary to develop materials that are well tolerated by osteoporotic bone and even to cover them with substances that can enhance integration. The mechanical properties of bone depend on tissue strength and composition, structural heterogeneity, and the extent and nature of microdamage. Alterations in these properties determine impairment in bone strength and quality. Bone strength translates into its capability to resist deformation (stiffness), to adapt to repetitive loads (resistance to fatigue) and to inhibit the progression of a lesion (resistance to fracture) (11). Bone tissue is made up of a mineral component, which confers strength and stiffness, and a protein component, which reduces the damage due to impact and affects mechanical properties: both these components decrease with age (12). In an osteoporotic condition bone structural heterogeneity is characterized by increased anisotropy (more trabeculae oriented along the main load axis, with respect to perpendicular ones) and then by increased fracture risk in response to non-physiological loads, like those generated by a fall. In radiographic images of trabecular bone, this phenomenon translates into the typical "comb" appearance, in which there is a reduction in the transverse elements which stabilize the vertical ones, while the latter are preserved, although thinned (13). A diagnostic imaging technique which is useful in highlighting micro-trabecular alterations and structural thinning of bone is 3-D spiral computed 64-layer tomography: we are successfully testing it on bone tissue specimens taken during surgical intervention requiring removal of the femoral head. Microdamage is the expression of the accumulation of mechanical stimuli in bone tissue. Microdamage increases with advancing age, and probably cannot be faced by physiological repair mechanisms, due to "laziness" on the part of osteoblasts (13). Even deterioration of joint mechanics due to advancing age can predispose to fracture: osteoarthritis, for example, generates a great torsional load on the femoral neck, and increases fracture risk in osteoporotic subjects, frequently determining a spiral shape of the fracture. Moreover, there is imbalance between systemic and local factors, both anabolic and catabolic, that influence bone metabolism; it is well-known, for example, that estrogens regulate bone turnover stimulating bone formation. In post-menopausal women lack of estrogens removes this stimulating effect (14). Calcium and vitamin D are also fundamental for bone

and musculoskeletal trophism, hence the absolute need to take them, as their metabolism is impaired with increasing age.

Initiatives to improve surgical outcome

Both fracture risk and surgical outcome are influenced by bone quality. Therefore, implants must be right for osteoporotic bone. Bone-implant interfaces must be optimal in order to avoid the concentration of mechanical stress over limited areas and to distribute forces homogeneously. The cut-out risk may be reduced by increasing the implant surface perpendicular to the applied load direction, perhaps using blades or helicoidal screws. The extractive strength of the screws which anchor implants to bone may be increased by locking them to the implant itself. A system in which the head of the screw is fixed to the plate hole or to the blockage holes of intramedullary nails can be applied. Implants with diverging blocked screws grant rigid fixation of fragments even in osteoporotic bone (15). Other strategies to enhance fracture healing in osteoporosis include the use of osteo-inductive and osteo-conductive materials, poly-methyl-methacrylate (PMMA) or reabsorbable materials (calcium phosphate, hydroxyapatite) in order to enhance implant fixation, and the addition of antiresorptive agents to PMMA and hydroxiapatite (8). Several studies have attempted to find substances able to enhance implant fixation and bone regeneration in animals. Recombinant human bone morphogenic protein-2 (rh-BMP-2) with a calcium-phosphate carrier seems to enhance fracture repair in rabbits (16). Osteogenic cells can be isolated from bone marrow and transferred to calcium-carbonate coated implants by means of bio-absorbable fibrin scaffolds (experimental in mice). Mesenchymal cells (MSCs) are able to differentiate into adipocytes, chondrocytes, osteoblasts and myoblasts in vitro (17), but their clinical use often causes pain and malaise, so alternative sources of MSCs are required. One seems to be adipose tissue, a more abundant and accessible source, from which processed lipoaspirate (PLA) cells, which can generate chondrogenic and osteogenic cells, may be obtained (18). The efficacy of hydroxyapatite in improving the stability of external fixation, even reducing the risk of complications, has been shown in clinical studies on wrist and femoral fractures (19). Studies conducted *in vivo* in mice using zoledronic acid + hydroxyapatite or pamidronate + PMMA in the treatment of experimental fractures show good local release of the agents while preserving the mechanical properties of the implants (20, 21). As for osteoporotic vertebral fractures, techniques such as vertebroplasty grant stabilization of the spine through a posterior, less traumatic, access and its association with "open" surgery may enhance screw fixation. In addition, the use of pedunculated screws with radial expansion points seems to increase the extractive strength of vertebral osteoporotic bone by 50%. The use of anti-osteoporotic drugs as adjuvants may improve surgical outcomes, decreasing secondary fracture risks at the same time. Intermittent subcutaneous administration of teriparatide (human recombinant parathyroid hormone 1-34) has increased bone formation and implant torsional and extractive strength in rats (22). In a study conducted in 21 post-menopausal women with low bone mineral density (BMD), bone biopsies of the iliac crest were taken in order to evaluate the early effects of teriparatide with two different tetracyclines (before and during treatment) to mark the newly formed bone. The treatment greatly stimulated new bone formation, both endocortical and trabecular, by increasing matrix apposition and involving previously quiescent surfaces (23). These results make the positive effect of teriparatide on bone implant fixation and fracture healing even more likely.

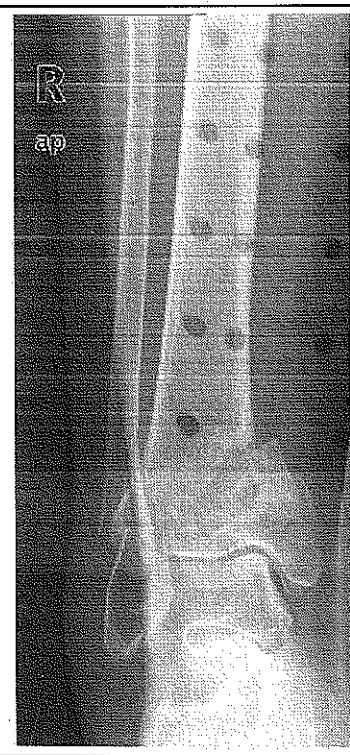

Fig. 1 - *X-ray showing ankle fracture.*

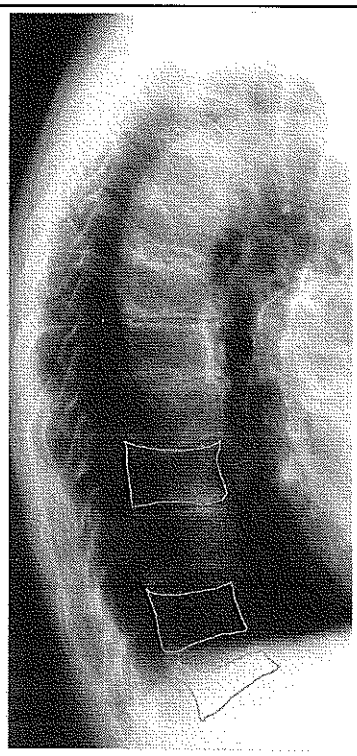

Fig. 2 - X-ray showing previous vertebral fractures.

Personal experience

We used teriparatide as an anabolic anti-osteoporotic drug in subjects with various characteristics and needs: women with a diagnosis of severe osteoporosis, fragility fracture women not fitting the traditional definition of severe osteoporosis, and non-osteoporotic subjects, in whom it was necessary to stimulate or accelerate fracture healing. In the 57 patients with severe osteoporosis (aged between 53 and 93) and in the 11 women with fragility fractures (aged between 62 and 76) we have obtained excellent results in terms of pain reduction and regaining of autonomy, with very high compliance to therapy and very good drug tolerability. An example is a 77-year-old woman treated for an ankle fracture due to low-energy indoor trauma (Fig. 1). During hospitalization, a spine X-ray showed three previous vertebral fractures (Fig. 2). She also had a T-score indicative of osteoporosis as evaluated by dual X-ray absorptiometry (DXA). She started treatment with teriparatide 20 μg/day subcutaneously 23 days after surgical treatment of the fracture with plates and screws (Fig. 3). Six months after surgery the implants were removed (Fig. 4) and the subject restarted full daily activity, continuing therapy for 18 months. Only 3 patients with severe

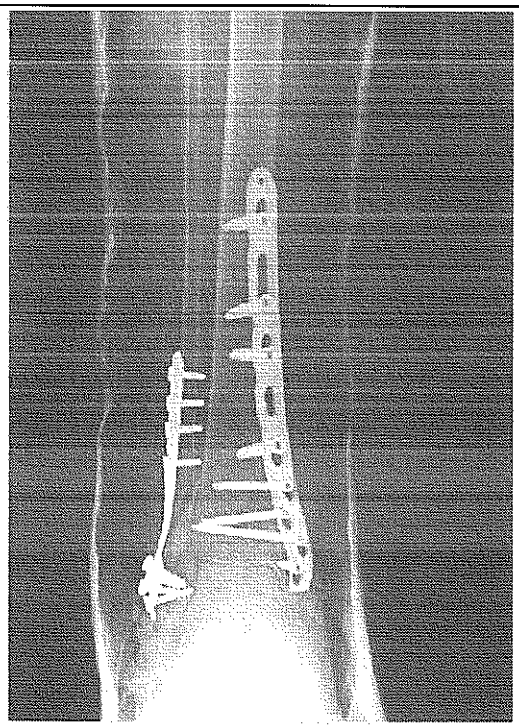

Fig. 3 - *First X-ray control immediately after intervention.*

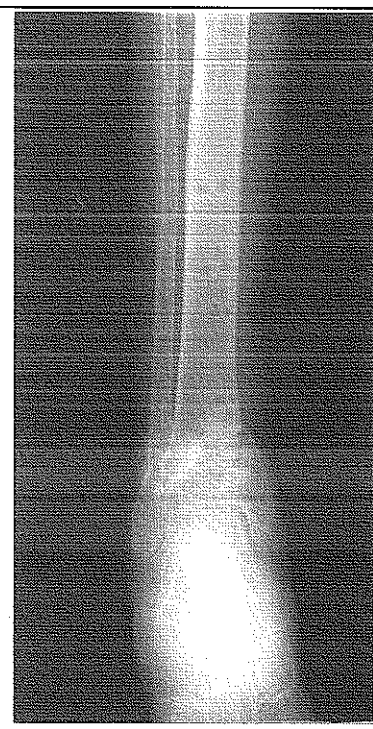

Fig. 4 - *X-ray 6 months later, after bone implant had been removed.*

osteoporosis aged 66, 76 and 81 years, respectively, interrupted treatment early. The causes were: dizziness in one patient, skin rash in one patient, and severe comorbidities in another. Table 1 lists the 34 surgical patients who were administered teriparatide early after intervention. Indicated are pa-

Table 1 - *Surgical patients who received teriparatide.*

Patients	Age	Sex	Diagnosis	Energy of trauma	Duration of therapy	Surgical outcome
S. R.	38	M	Diaphyseal tibial and fibular fracture	High	3 months	Healed
Q. E.	25	M	Non-union of radius and ulna	High	5 months	Healed
M. L.	41	M	Supra-condylar femoral fracture	High	3 months	Healed
S. E.	56	M	Tibial plate fracture	High	3 months	Healed
T. F.	32	F	Non-union of radius and ulna	High	5 months	Healed
M. V.	39	M	Bilateral radial fracture	High	3 months	Ongoing
C. S.	38	M	Pelvic and diaphyseal femoral fracture	High	2 months	Ongoing
A. G.	57	M	Cervical undisplaced femoral fracture	Moderate	1 month	Ongoing
F. G.	67	M	Ankle fracture	Moderate	3 months	Healed
F. S.	49	F	Ankle fracture	Low	2 months	Ongoing
M. C.	77	M	Cervical displaced femoral fracture	Low	3 months	Ongoing
S. A.	70	F	Proximal humeral displaced fracture	Low	3 months	Healed
M. M.	66	F	Ankle fracture	Low	5 months	Healed
B. M.	62	F	Cervical undisplaced femoral fracture	Low	3 months	Healed
F. M.	63	F	Cervical undisplaced femoral fracture	Low	3 months	Healed
B. R.	73	F	Cervical undisplaced femoral fracture	Low	18 months	Healed
B. C.	68	F	Trochanteric femoral fracture	Low	Interrupted	Healed
C. I.	83	F	Vertebral fracture	Low	18 months	Healed
C. F.	76	F	Trochanteric femoral fracture	Low	Interrupted	Healed
C. G.	77	F	Ankle fracture	Low	18 months	Healed
M. M.	93	F	Cervical displaced femoral fracture	Low	18 months	Healed
M. E.	85	F	Proximal humeral fracture	Low	18 months	Healed
M. G.	79	F	Trochanteric femoral fracture	Low	18 months	Healed
O. L.	76	F	Broken gamma-nail	Low	18 months	Healed
L. M.	71	F	Cephalic screw cut-out (gamma-nail)	Low	18 months	Healed
P. A.	69	F	Trochanteric femoral fracture	Low	18 months	Healed
S. C.	77	F	Trochanteric femoral fracture	Low	18 months	Healed
S. M.	84	F	Vertebral fracture	Low	18 months	Healed
V. I.	82	F	Cervical displaced femoral fracture	Low	18 months	Healed
V. E.	85	F	Trochanteric femoral fracture	Low	18 months	Healed
Z. N.	81	F	Trochanteric femoral fracture	Low	18 months	Healed
G. G.	40	M	Aseptic necrosis of femoral head	-	4 months	Ongoing
M. V.	75	F	Infected hip prosthesis	-	6 months	Healed
O. A.	64	M	Infected knee prosthesis	-	6 months	Healed

tients' age, sex, diagnosis, energy of trauma in fractured patients, duration of teriparatide therapy and surgical outcome. Table 2 shows patients' perception of pain, as evaluated by a Visual-Analogical Scale (VAS) before (VAS 0) and after treatment (VAS 1), and their compliance to teriparatide treat-

Table 2 - *Efficacy of teriparatide on pain and patients' compliance with therapy.*

Patients	Age	Sex	Energy of trauma	VAS 0	VAS 1	Compliance
S. R.	38	M	High	2	0	Good
Q. E.	25	M	High	6	0	Good
M. L.	41	M	High	6	0	Good
S. E.	56	M	High	4	0	Good
T. F.	32	F	High	6	0	Good
M. V.	39	M	High	7	-	Good
C. S.	38	M	High	9	-	Poor
A.G.	57	M	Moderate	8	-	Good
F. G.	67	M	Moderate	7	2	Good
F. S.	49	F	Low	4	-	Good
M. C.	77	M	Low	6	-	Good
S. A.	70	F	Low	4	0	Good
M. M.	66	F	Low	0	0	Good
B. M.	62	F	Low	6	6	Poor
F. M.	63	F	Low	8	4	Good
B. R.	73	F	Low	9	4	Good
B. C.	68	F	Low	8	8	Poor
C. I.	83	F	Low	8	5	Good
C. F.	76	F	Low	6	6	Poor
C. G.	77	F	Low	6	4	Good
M. M.	93	F	Low	9	7	Poor
M. E.	85	F	Low	7	4	Poor
M. G.	79	F	Low	7	4	Good
O. L.	76	F	Low	9	6	Good
L. M.	71	F	Low	9	7	Good
P. A.	69	F	Low	9	6	Poor
S. C.	77	F	Low	8	6	Good
S. M.	84	F	Low	9	6	Poor
V. I.	82	F	Low	7	4	Poor
V. E.	85	F	Low	9	6	Poor
Z. N.	81	F	Low	9	6	Poor
G. G.	40	M	-	-	-	Good
M. V.	75	F	-	-	-	Good
O. A.	64	M	-	-	-	Good

Table 3 - *DXA values in surgical patients.*

Patients	Age	Sex	Energy of trauma	DXA lumbar spine	DXA femoral neck	Previous fractures
S. R.	38	M	High	-0.6	-1.4	No
Q. E.	25	M	High	1.5	2.0	No
M. L.	41	M	High	-1.0	0.3	No
S. E.	56	M	High	-2.6	-3.7	No
T. F.	32	F	High	-0.7	1.0	No
M. V.	39	M	High	-0.4	-0.8	No
C. S.	38	M	High	-0.2	-	No
A.G.	57	M	Moderate	-1.9	-2.6	No
F. G.	67	M	Moderate	-0.8	-1.1	No
F. S.	49	F	Low	-1.8	-2.4	No
M. C.	77	M	Low	2.1	1.3	No
S. A.	70	F	Low	-2.8	-1.2	No
M. M.	66	F	Low	-2.9	-1.6	No
B. M.	62	F	Low	-2.6	-1.5	No
F. M.	63	F	Low	-2.6	-1.9	No
B. R.	73	F	Low	-0.3	-2.3	Yes
B. C.	68	F	Low	-2.7	-2.9	Yes
C. I.	83	F	Low	-1.9	-2.3	Yes
C. F.	76	F	Low	-2.7	-3.0	Yes
C. G.	77	F	Low	-4.3	-4.1	Yes
M. M.	93	F	Low	-2.4	-	Yes
M. E.	85	F	Low	-4.6	-3.2	Yes
M. G.	79	F	Low	-3.2	-2.8	Yes
O. L.	76	F	Low	-0.7	-2.1	Yes
L. M.	71	F	Low	-3.3	-2.9	Yes
P. A.	69	F	Low	-3.6	-3.7	Yes
S. C.	77	F	Low	1.0	-2.4	Yes
S. M.	84	F	Low	-3.0	-	Yes
V. I.	82	F	Low	-4.6	-2.1	Yes
V. E.	85	F	Low	-5.0	-3.7	Yes
Z. N.	81	F	Low	-2.9	-2.2	Yes
G. G.	40	M	-	-	-	-
M. V.	75	F	-	-3.0	-1.0	-
O. A.	64	M	-	1.6	1.3	-

ment. Twenty-two patients (66%) showed good compliance and a decrease in pain perception. Tables 3 and 4 list BMD values obtained by DXA, previous fractures and bone turnover markers in the same patients. Table 5 shows details of the patients who received spine X-ray and the prevalence

Table 4 - *Bone turnover markers at time of surgical intervention.*

Patients	Age	Sex	Energy of trauma	Serum calcium	B-cross laps	Osteocalcin
S. R.	38.	M	High	8.68	0.38	9.06
Q. E.	25	M	High	9.01	1.72	11.45
M. L.	41	M	High	7.98	1.99	10.01
S. E.	56	M	High	8.4	0.41	8.70
T. F.	32	F	High	8.2	0.53	9.98
M. V.	39	M	High	7.98	0.587	12.35
C. S.	38	M	High	8.8	1.66	18.43
A. G.	57	M	Moderate	8.1	0.463	8.51
F. G.	67	M	Moderate	8.88	0.704	11.75
F. S.	49	F	Low	8.7	0.43	9.63
M. C.	77	M	Low	8.1	0.59	12.52
S. A.	70	F	Low	7.99	0.683	21.71
M. M.	66	F	Low	8.3	1.04	10.12
B. M.	62	F	Low	8.92	0.277	9.87
F. M.	63	F	Low	9.2	0.704	11.75
B. R.	73	F	Low	9.1	0.55	15.97
B. C.	68	F	Low	8.6	1.79	12.00
C. I.	83	F	Low	8.2	1.02	10.01
C. F.	76	F	Low	8.9	0.9	21.30
C. G.	77	F	Low	8.6	1.29	31.00
M. M.	93	F	Low	8.01	1.23	13.43
M. E.	85	F	Low	9.4	1.80	126.80
M. G.	79	F	Low	8.2	0.821	8.98
O. L.	76	F	Low	9.03	0.767	16.44
L. M.	71	F	Low	7.0	1.34	12.77
P. A.	69	F	Low	8.5	1.7	11.75
S. C.	77	F	Low	9.7	1.64	13.00
S. M.	84	F	Low	8.8	1.13	31.58
V. I.	82	F	Low	8.6	0.648	25.03
V. E.	85	F	Low	8.1	0.98	27.00
Z. N.	81	F	Low	7.9	1.01	23.40
G. G.	40	M	-	-	-	-
M. V.	75	F	-	8.84	1.6	30.12
O. A.	64	M	-	9.3	0.52	8.26

Table 5 - *Spine X-rays in surgical patients.*

Patients	Age	Sex	Energy of trauma	Spine X-ray	Vertebral fracture
S. R.	38	M	High	N	-
Q. E.	25	M	High	N	-
M. L.	41	M	High	N	-
S. E.	56	M	High	N	-
T. F.	32	F	High	N	-
M. V.	39	M	High	N	-
C. S.	38	M	High	N	-
A. G.	59	M	Moderate	Y	No
F. G.	67	M	Moderate	N	-
F. S.	49	F	Low	Y	No
M. C.	77	M	Low	N	No
S. A.	70	F	Low	Y	L3
M. M.	66	F	Low	Y	T12
B. M.	62	F	Low	Y	No
F. M.	63	F	Low	Y	No
B. R.	73	F	Low	Y	T10, T11,T12
B. C.	68	F	Low	Y	T11, T12
C. I.	83	F	Low	Y	L1
C. F.	76	F	Low	Y	T12, L1
C. G.	77	F	Low	Y	T9, T11, T12
M. M.	93	F	Low	Y	T9, T10, T11, T12
M. E.	85	F	Low	Y	No
M. G.	79	F	Low	Y	T11,L1,L3
O. L.	76	F	Low	Y	T10,T11,L2
L. M.	71	F	Low	Y	T11,T12,L1
P. A.	69	F	Low	Y	T10,T11,L2
S. C.	77	F	Low	Y	No
S. M.	84	F	Low	Y	L2
V. I.	82	F	Low	Y	L1
V. E.	85	F	Low	Y	L2,L3,L4
Z. N.	81	F	Low	Y	No
G. G.	40	M	-	-	-
M. V.	75	F	-	-	-
O. A.	64	M	-	-	-

of vertebral deformities in this group (44%). Lastly, Table 6 indicates the traumatic mechanism. Subjects who took teriparatide in order to improve the surgical outcome and to shorten healing time had emphatically asked for a solution which could allow them to go back to their professional and sports activities rapidly. In these subjects faster healing and an earlier return to normal life were achieved with respect to those expected according to fracture type.

Table 6 - *Traumatic mechanism.*

Patients	Age	Sex	Energy of trauma	Type of trauma
S. R.	38	M	High	Street accident
Q. E.	25	M	High	Street accident
M. L.	41	M	High	Street accident
S. E.	56	M	High	Street accident
T. F.	32	F	High	Street accident
M. V.	39	M	High	Street accident
C. S.	38	M	High	Street accident
A. G.	57	M	Moderate	Home fall
F. G.	67	M	Moderate	Ankle sprain - outdoor
F. S.	49	F	Low	Ankle sprain - indoor
M. C.	77	M	Low	Home fall
S. A.	70	F	Low	Home fall
M. M.	66	F	Low	Ankle sprain - outdoor
B. M.	62	F	Low	Home fall
F. M.	63	F	Low	Home fall
B. R.	73	F	Low	Home fall
B. C.	68	F	Low	Home fall
C. I.	83	F	Low	Home fall
C. F.	76	F	Low	Home fall
C. G.	77	F	Low	Home fall
M. M.	93	F	Low	Home fall
M. E.	85	F	Low	Home fall
M. G.	79	F	Low	Home fall
O. L.	76	F	Low	Inapparent trauma
L. M.	71	F	Low	Inapparent trauma
P. A.	69	F	Low	Home fall
S. C.	77	F	Low	Home fall
S. M.	84	F	Low	Home fall
V. I.	82	F	Low	Home fall
V. E.	85	F	Low	Home fall
Z. N.	81	F	Low	Home fall

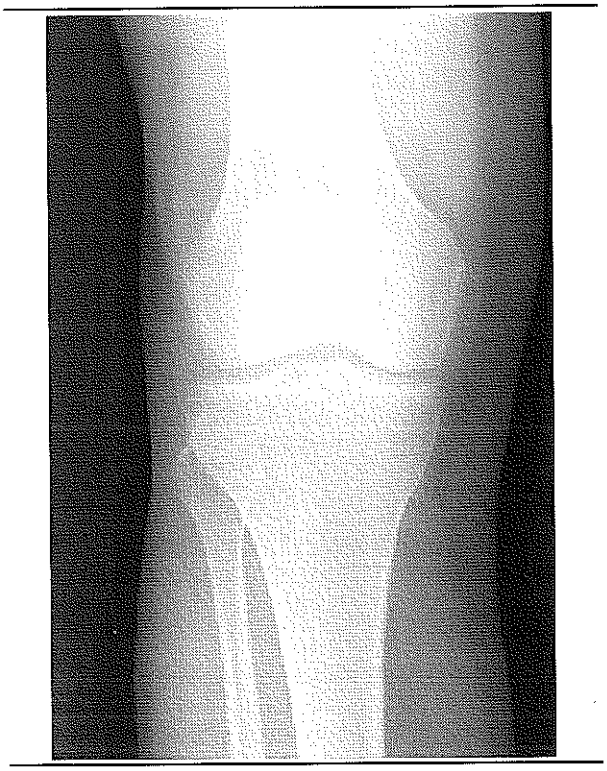

Fig. 5 - *X-ray showing tibial plate fracture of right knee.*

For example, we treated a 56-year-old man with a displaced diaphyseal fracture of tibial plate of the right knee due to high-energy trauma (Fig. 5), who needed to go back to his work and sport activity in a short time for personal reasons. It was necessary to take CT scans to evaluate the course of the fracture (Fig. 6). He was seen to be osteoporotic at DXA. He started treatment with teriparatide (20 μg/day subcutaneously) 3 days after surgical treatment of the fracture with screws and calcium phosphate (Figure 7). Thirty days after surgery, he was allowed to walk with crutches and half load-bearing on the right lower limb. He reported that he was totally free of pain even during walking. Due to his improved clinical conditions and lower limb function, teriparatide was stopped after 3 months. Five months after intervention, the patient walked without aid, was completely free of pain or functional limitation, and regularly went to work.

CONCLUSIONS

There are several solutions to face problems encountered with surgical implants on osteoporotic

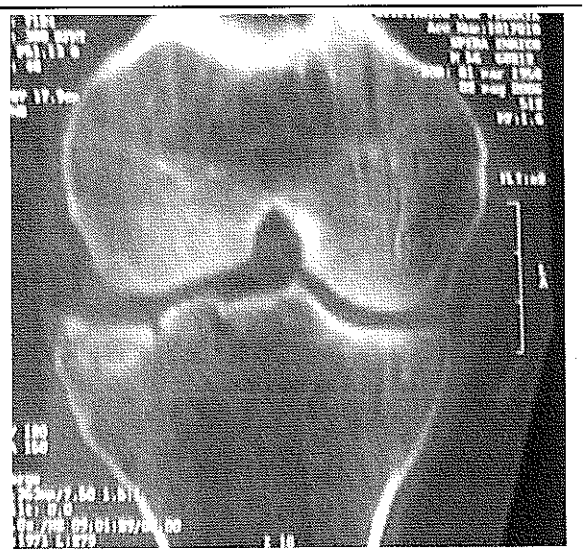

Fig. 6 - *Computed tomography appearance of knee fracture.*

bone, but orthopedic surgeons must be more deeply involved in the pathophysiologic, clinical and biomechanical aspects of osteoporosis in order to apply available therapeutic measures properly, to test their effectiveness, and to develop new options. This is the only way to improve the quality of life of osteoporosis fracture patients. Teriparatide has been demonstrated to increase bone response to fracture and other pathologic stimuli. It may also be useful in conditions which require a stronger response of bone to orthopedic treatment.

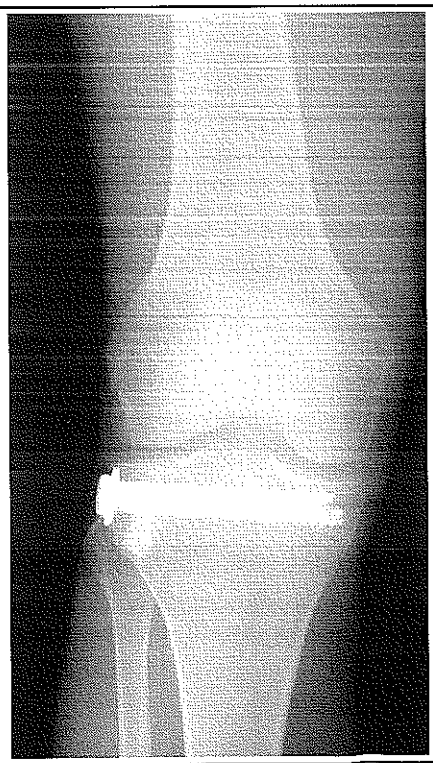

Fig. 7 - *First X-ray control immediately after intervention.*

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