



**ORIGINAL RESEARCH PAPER**

**Orthopaedic**

**IMPACT ANALYSIS OF AND REASONS FOR OSTEOPOROTIC BONE FRACTURES**

**KEY WORDS:** arthroplasty, bone fractures, DHS method, kyphoplasty, Targon®FN system, vertebroplasty

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**ABSTRACT** This article describes selected techniques for treating the most common fractures due to osteoporosis based on the studies and practices described, in order to make a short summary for biomedical and medical student’s needs. Osteoporotic fractures occur spontaneously in the elderly or with unreasonably small accident. The most important and the most serious consequences for a person affected by this disease are low and high energy fractures. Fractures of the vertebrae and upper femur result in disability, dependence of the affected person on the help and unfortunately, premature death. The review article is designed to help biomedical and medical students study orthopedic fractures related to osteoporosis.

**INTRODUCTION**

According to the World Health Organization (WHO), osteoporosis is a systemic disease that leads to a change of the bone structure, bone loss and refers to the entire skeleton. **Fracture of the femoral neck is also a problem in clinical practice, as it covers approximately 7% of all fractures in Poland, and about 30% of them happen in people older than 60 years. According to Slovak statistics, nearly 40,000 new fractures will increase with people older than 50 years in Slovakia every year. In case of older people, the density and quality of the bones gradually are decreasing, which means that the risk of fractures is increasing, especially in the spine, wrist and femur. Only in 2009, 27,645 fractures of the proximal femur of the bones were reported in Poland between 167,663 low-energy broken fractures. Slovakia and Poland belong to countries with a higher number of fractures. Fracture of the femoral neck is considered the most severe fracture with low energy because it immobilizes the patient; 25% of people regain physical fitness, 25% die and 50% have impaired physical fitness. Fractures in older people can't be neglected.**

**CAUSES OF OSTEOPOROTIC BONE FRACTURES**

Basically, it can assume that there are three main fracture causes, called pathways. The causes of fractures are illustrated in Fig. 1A.

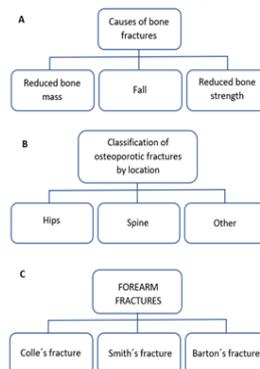
In elderly people, fractures are caused by a combination of listed reasons in Fig. 1B (which often occur simultaneously). Ordinary falls, which are relatively common in the elderly, pose a very serious problem.

As people age, falls occur more frequently. According to statistics, about 30% of people over 75 years old fall over at least once a year. There are several causes of falls. The most common are visual disturbances, followed by cardiological and neurological disorders. Falls also cause 30% of the vertebral fractures, almost 100% of the forearm fractures and

90% of fractures in the hip area. The categories of osteoporotic fractures are shown due to their location in Fig. 1B.

The most common osteoporotic fractures are fractures of the femur and the vertebral bodies in the spine. There are also fractures of the radius, humerus, collarbone, shoulder and pelvis grouped in other categories. It should be noted that the location of fracture changes with age. For the age group 50 – 55 years, radial fractures are the most common, mainly at the distal end. For the age group from 65 to 70 years, the vertebral body fractures dominate. Over the age of 70, hip fractures occur most frequently.

The most common cause of fracture of the forearm bones is a fall from the height. It is accompanied by an unsuccessful protection from its effects. Their frequency increases in the winter, which is due to the deterioration of adhesion to the substrate (due to frost and snow). The categories of fractures of the forearm bones are shown in Fig. 1C.



**Figure 1: A: Causes of bone fractures, B: Classification of osteoporotic fractures by location, C: Classification of fractures of the forearm bone**

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In the case of Colle's fracture, the distal radius is displaced in the dorsal direction.

This is the most common type of fracture near the wrist (about 90 %). Smith's and Barton's fractures are much less frequent. Smith's and Barton's (distal radius) fractures are much more common (about 4 – 6 times) in women than in men. The frequency of this type of fracture starts to increase from the age of 40 and stabilizes around the age of 65 because older women fall more often to the side and to the area of buttocks breaking the hip or spine, and less often to the front - injuring the forearm bones. After the fracture of the wrist, the probability of occurrence of the fracture of the vertebral body increases by 5 times for women and 10 times for men.

Treatment is mostly performed through repositioning and immobilization in a gypsum rail (plaster cast or splints), only for neurological disorders or instability detected in RTG, patients are operated on (approximately 20%).

**In the case of fractures of this type, complications occur, but they are not fatal.**

Vertebral body fractures are the most common type of fractures. They belong to a group of compression fractures. Among the vertebral fractures, the following can be differentiated: wedge, biconcave and compression fractures. Each fracture can have three variations: minor, medium and heavy. Only 30% of vertebral fractures relate to fall, the remaining fractures result from minor injuries and occur due to earlier damages of the bone. In some cases, the reason of fracture can be as trivial as a sneeze. Almost half of the fractures have no symptoms. The incidence of fractures is increasing with age and it is more common in women. Damage to the shafts is very common in cases where greater forces are involved, i.e. Th8-L2 of the spine. A fracture of a single vertebra means a significant increase in the risk of another fracture. Fractures often occur asymptotically. If symptoms occur, they include acute pains, symptoms associated with nerve root compression, i.e. paresis, increased thoracic kyphosis (so-called widow's hump) and loss of height.

**MATERIALS AND METHODS**

In the case of fracture of the forearm bones, gypsum immobilization and rehabilitation are used most frequently. The mortality of patients is by no means influenced by distal radius fracture. Surgical treatment is only used in about 20% of cases. Indications for surgical treatment are neurological disorders or instability seen in RTG. Surgical treatment is limited to the repositioning of bone fragments and stabilization with metal rods, plates or external stabilizers.

In the case of fractures of the proximal femur, conservative treatment does not exist. In the case of femoral neck fractures, endoprostheses are most commonly used. Other surgical methods used for stabilization include: the combination of DHS (Dynamic Hip Screw), Targon®FN, Intramedullary Nails (Targon®PF) (Fig. 2A). Targon®PF intramedullary nail implantation allowed for full stability of the fractures and the operated limb can be burdened immediately.

DHS (Dynamic Hip Screw) treatment contributes in achieving these goals to a large extent.

Fig. 2B1 and 2B2 show an intertrochanteric fracture and the same fracture with the applied DHS method. The DHS method involves inserting a screw (of the appropriately selected length) into the femoral neck and then connecting it to a plate that is fixed to the femoral shaft with cortical screws. The screw is inserted exactly in the femoral neck, at a depth of about 10 mm from the bone surface of the femoral head. After assembling the set (screw-plate), the stabilization of the joint is achieved. Such a connection prevents mutual rotations of

the bone fragments.

When intertrochanteric fracture is treated with the DHS method (Fig. 2C), the immediate immobilisation of the limb allows achieving the main objective of the method, i.e. stable fixation of the bone fragments, and additionally it allows the limb to be burdened.

However, the best stability, in terms of biomechanics, is achieved by intramedullary nailing such as PFN, Gamma or Targon®PF. These implants allow patients to be fully active after the operation. They also allow the operated limb to be totally loaded. The above connections are also applied in the case of subtrochanteric fractures. The most frequent subtrochanteric fractures occur in the elderly after falling over to the side. Approximately 90% of these are oblique fractures with bone displacements, which are highly influenced by muscle functioning.

Surgical treatment of a femoral fracture is not a choice but a necessity due to the significantly high mortality rate of untreated patients. Surgical treatment accelerates recovery of patients with osteoporotic fractures.

However, if there are contraindications to surgical treatment, this type of therapy is discontinued. Patients treated conservatively are found to demonstrate significant degree of disability and the high mortality rate. If surgical treatment after hip fracture is abandoned, 12% to 40% of patients die, 60% in the first year after the injury and 20% in the first month after the fracture.

The femoral neck fracture relates to people about 3 years younger than in the case of the intertrochanteric fracture. This may indirectly mean that the neck structure is mechanically weaker than the trochanter. The femoral neck fracture can relate both normal and weak bone tissues. Fracture of normal bone tissue, especially in young people, is a high energy fracture resulting from road accidents or sports injuries. Low energy fracture occurs when a person falls (from the body level). The pathomechanism of fracture is explained by the disproportion between the significant mechanical strength of the joint capsule and an extreme, traumatic, rotational external movement of the femur. Another mechanism results from the indirect action of the vectors of traumatic forces on the greater trochanter in a varying degree of its rotation and the mechanical transfer of the force onto the femoral neck. Depending on the degree of rotation of the trochanter, the values of forces of an indirect injury exceeding the strength of the bone tissue of the neck are transferred to it, causing its fracture (at its various length) within the joint capsule which has a strong structure. Fractures of the femoral neck are intracapsular fractures. Morphological component of low energy fracture is a weakened structure of bone tissue following several diseases and ageing factors affecting bone turnover (osteoporosis, osteomalacia, renal failure, thyroid diseases, hormonal factors, nutritional deficiencies and others). Unstable fractures (Fig. 2D) require implants which would change shear forces into downforces, which will optimize bone healing - the effect is achieved by positioning metal fasteners "intoed" never "out-toed". Thus, the ideal solution will be a stabilizing system, which would stimulate bone healing according to biological principles of bone healing by dynamization.

Stabilization with the help of Targon®FN telescopic screws meets these requirements. The use of screws conditions as trustworthy proximal anchorage, while the use of a plate with angle stabilizer ensures a solid distal anchorage. The connection prevents rotational movements. This technique does not involve a lot of surgical invasion. Positive experience with this technique recommends it as a solution for healing of the intracapsular femoral neck fracture (Martyn Parker, Hans-Werner Stedtfeld). The Targon®FN system consists of

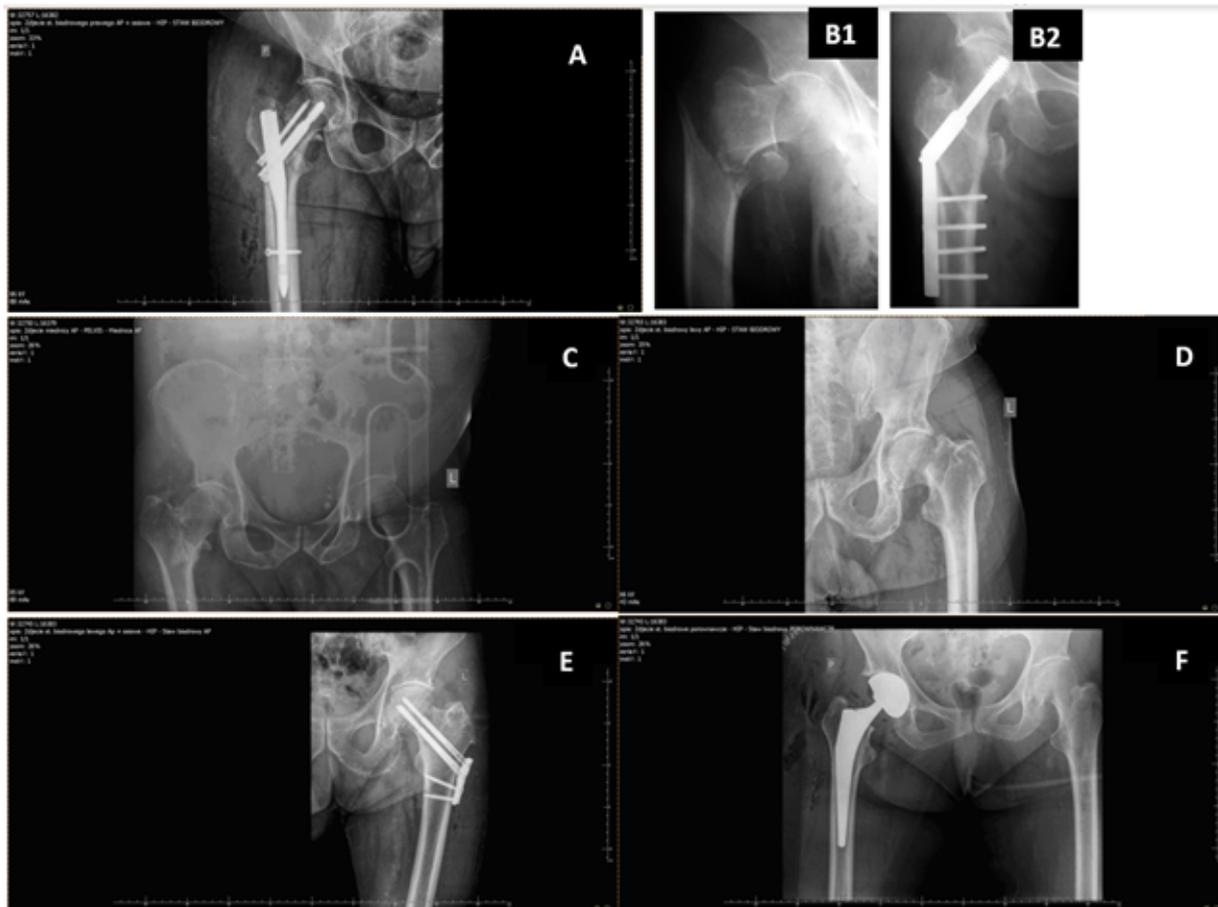
telescoping sliding screws (which go into the femoral neck) for dynamizing the fixation. The screws are stabilized with an angular-stable plate. The kit includes also bolts which fix the Targon<sup>®</sup>FN system to the femoral shaft (Fig. 2E).

The system meets expectations relating stabilization and dynamization of the fixation thanks to axial compression of bone fragments and rotational stability and because the implanted screws match the angle of fracture. Telescoping screws change the shear force into the pressure (dynamic) and additionally the distal bolts stabilize the system to the femur shaft.

In femoral neck fractures, apart from fixing elements, there

are also optional hip alloplasty (Fig. 2F). Arthroplasty as a reconstructive treatment is stability and because the implanted screws match the angle of fracture. Telescoping screws change the shear force into the pressure (dynamic) and additionally the distal bolts stabilize the system to the femur shaft.

In femoral neck fractures, apart from fixing elements, there are also optional hip alloplasty (Fig. 2F). Arthroplasty as a reconstructive treatment is dedicated in cases where the hip is impossible to be healed by other methods. Total or partial endoprostheses are applied as well as cemented and uncemented endoprostheses.



**FIGURE 2:** A: Targon<sup>®</sup>PF intramedullary nail implantation, B: The Dynamic Hip Screw treatment: B1 – intertrochanteric fracture, B2 – the same fracture with the applied DHS method, C: Intertrochanteric fracture of right femur due to osteoporosis, D: Osteoporotic fracture of the neck of the left femur with displacement, E: Treatment of femoral neck fracture with Targon<sup>®</sup>FN system, F: Total uncemented arthroplasty of right hip joint.

In the case of vertebral fractures, conservative treatment is used in most cases (in approximately 90% of patients). Conservative treatment includes such methods as: orthopaedic corsetry (bracing), analgesic treatment, verticalization and rehabilitation. Surgical treatment is based on vertebroplasty and kyphoplasty. Surgical methods are used for severe pains and significant neurological disorders in about 10% of patients.

Vertebroplasty is one of the methods of treating compression fractures of the spine. This procedure involves injections of bone cement into the shaft of the fractured or almost fractured vertebrae. This procedure is performed under general spinal anaesthesia or local anaesthesia. A surgeon inserts a needle into the intervertebral joint. The needle is introduced into the

vertebral body and then bone cement is applied, which reinforces the given vertebrae. The operation is monitored in real time with the X-ray preview. Kyphoplasty is another treatment method of compression fracture. It involves stabilization of the fracture and correction of the distortion of the vertebral body with a balloon. The procedure of the kyphoplasty consists in placing a guide bar in the interior of the fractured body. The balloon is introduced with the guide bar. The balloon is filled with contrast fluid. The balloon lifts the broken body and makes some space for cement delivery. After reconstructing the correct shape of the body, the balloon is emptied and removed from the guide bar. The spaces inside the body are filled with low pressure cement. The most commonly used cement is a mixture consisting of polymer and monomer.

**CONCLUSIONS**

The predominant method of the osteoporotic fracture therapy, especially in the upper limb, is undoubtedly the conservative treatment. It should be remembered, though, that vast majority of fractures are asymptomatic. They remain undiagnosed and untreated in any way. Diagnosed fractures are subject to various methods but which method should be and will be used, depends on the physician's, conditioned, in

turn, by any other co-occurring diseases.

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