

Commentary on the systematic review “Osteoporotic Vertebral Fractures: predictive factors for conservative treatment failure”

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Abstract

Osteoporosis is a worldwide disease and osteoporotic vertebral fractures (OVFs) have a high incidence in the elderly population, mostly involving female sex in the postmenopausal status. They are usually treated conservatively with a bed rest period, pain control with analgesics, bracing, bisphosphonates and early rehabilitation. Nevertheless, this kind of treatment can fail with persistent pain, collapse, pseudoarthrosis, kyphotic deformity and neurologic impairment. Therefore, there is the necessity to identify clinical, radiographic and magnetic resonance parameters that might predict risk of complications and conservative treatment failure of osteoporotic vertebral fractures. According to the literature and our experience, major risk factors are the presence of intravertebral cleft, middle column damage, thoracolumbar involvement, superior endplate fracture, a large bony fragment. In conclusion, shape and level of the fracture are risk factors associated with failure of the conservative treatment and therefore in selected cases a surgical treatment might be considered.

Osteoporosis and Osteoporotic Vertebral Fractures

Osteoporosis is a worldwide disease characterized by reduction of bone mass and alteration of bone architecture, which results in increased bone fragility and increased fracture risk. Causes of osteoporosis include elderly age, hypogonadism or premature ovarian failure, ethnic background, rheumatoid arthritis, low bone mineral density (BMD), vitamin D deficiency, low calcium intake, hyperkyphosis, current smoking, alcohol abuse, immobilization, chronic use of corticosteroids. About 200 million people suffer from osteoporosis and approximately 8.9 million fractures are related to it. These fractures occur mainly at the hip, vertebrae, and distal forearm. Osteoporotic vertebral fractures (OVFs) have a high incidence in the elderly population, mostly involving female sex in the postmenopausal status. The number of patents is rapidly increasing and it is becoming an important socioeconomic health issue, as are strongly related to disability, quality of life decrease and higher risk of mortality due to cardiopulmonary complications.

Osteoporotic vertebral fractures are usually treated conservatively with a bed rest period, pain control with analgesics, bracing, bisphosphonates and early rehabilitation. The outcomes of the conservative treatment are usually good and the majority of the vertebral fractures heal with functional recovery and without deformities or pain. In few cases, complications may onset during the conservative treatment of Osteoporotic Vertebral Fractures, which are progression of vertebral collapse, pseudoarthrosis, hyperkyphosis and neurologic deficits. Even if they are rare, these may cause prolonged back pain, strong impairment of daily living activities and reduced quality of life, determining the failure of the conservative treatment.

Rationale for a Systematic Review

Recently, the importance of investigating risk factors associated with the onset of these complications has strongly risen. Therefore, a review of the current literature on the topic was performed, including studies which analyzed (1) vertebral collapse and its progression; (2) pseudoarthrosis (nonunion); (3) kyphotic deformity and (4) neurologic deficits as primary outcomes. Eligibility criteria were strict; patients must have received conservative treatment only and must not being affected by pathological fractures.

The Risk Factors for Conservative Treatment Failure from Literature

Several studies analyzed the vertebral collapse and its progression. Sugita et al. [1] proposed a new radiological classification for the osteoporotic vertebral fractures in five different types. The authors identified a good prognosis group, including concave and dented type, and a poor prognosis group, including swelled-front, bow-shaped and projecting type, in which the vertebral collapse was >50% at the follow-up examination. Yu et al. [2] found that loss of more than 50% of vertebral height was more frequent in patients with intravertebral air only or mixed with fluid, rather than those with intravertebral fluid only, in MR enhanced T1-weighted images. Kanchiku et al. [3] demonstrated that fractures with posterior wall involved showed higher MR non-contrast area percentage and vertebral collapse progression, compared to those with endplate or anterior wall damage. Omi et al. [4] found a significant difference in affected vertebrae with linear black signal area-which was a linear black signal occupying more than half the length of the vertebral body in MR STIR sequences-that showed higher vertebral collapse progression, when compared to those with nonlinear black signal area. Ha and Kim [5] noticed that thoracolumbar fracture, middle-column damage and posterior wall damage were important risk factors for progressive collapse. Kanchiku et al. [6] proposed a new magnetic resonance imaging-based classification, categorizing fractures into six types, according to T1 and T2-weighted image pattern. Frequency of vertebral collapse was greater for hypointense wide-type fractures and total hyperintense-wide-type fractures. Goldstein et al. [7] found that presence of Intravertebral cleft (IVC) was significantly correlated to collapse of more than 50% of the vertebral body and I was common in AO/OTA A2 and A4 fractures type.

Pseudoarthrosis can be a complication of conservative treatment. Wu et al. [8] noticed that fractures involving anterior and middle column greater risk of nonunion, than fractures involving only anterior column. Sugita et al. found that it was more likely to occur in thoracolumbar fractures and in swelled-front, bow-shaped and projecting types. Tsujio et al. [9] noticed that thoracolumbar fracture, middle-column damage and confined high intensity and diffuse low intensity area in the fractured vertebrae on T2-weighted MR images were significant risk factors for nonunion. Omi et al. [4] evidenced that non-homogenous high signal change and linear black signal area in MRI STIR sequences were a strong risk factor for nonunion. Kanchiku et al. [3] observed that total type, Hypointense-wide-type, total hyperintense-limited and total hypointense-wide-type fractures showed higher incidence of pseudoarthrosis.

Two studies examined the predictors of segmental kyphotic deformity in osteoporotic vertebral fractures, such as Patilet al. [10] one, who found that thoracolumbar junction and end-plate fractures were statistically significant risk factors for the onset of segmental kyphotic deformity >30° measured with Cobb angle. Goldstein et al. [7] found that AO type A2 and A4 fractures had high incidence of kyphotic deformity compared to A1 and A3 type.

Hosino et al. [11] analyzed the onset of neurological deficits and found that occupation by a bony fragment of more than 42% of sagittal diameter of the spinal canal on MR images and a change of more than 15° in vertebral wedge angle on lateral dynamic radiography contributed to the severity of the deficits.

It is a 3 years retrospective study of 180 patients from emergency department about the failure of the Osteoporotic Vertebral Fractures conservative treatment.

In this retrospective study analysis of the risk factors for conservative treatment failure was made. A cohort of 180 patients with 200 osteoporotic vertebral fractures were enrolled: fractures were divided in thoracic, thoracolumbar and lumbar levels, were classified in according to Sugita's [1] and Genant [12] classification, their MR STIR findings were evaluated if available and pathologic mechanism was taken in account. The progression of vertebral collapse was evaluated as primary outcome and a valor of progression of vertebral collapse >100% was taken as an independent variable in order to underline any statistically significant difference among the considered risk factors.

The Risk Factors for Conservative Treatment Failure from Our Retrospective Study

As for the shape, “swelling” and “bow shaped” type underwent a >100% progression of the vertebral collapse. The other fractures shape showed low percentage of progression of vertebral collapse and were defined as good prognosis by Sugita et al [1]. Concerning the level of fracture, thoracolumbar fractures tend to suffer much more from progression of vertebral collapse than thoracic and lumbar fractures, while for MR STIR findings, the “linear black signal” pattern showed a trend towards >100% progression of the vertebral collapse, compared to the “non-linear black signal”. Finally, for the pathologic mechanism, low evidences were found when comparing the fractures due to trauma with the non-traumatic fractures and the difference was not significant. The progression of vertebral collapse was chosen as primary outcome because it represents a common thread between all other complications in the conservative treatment of OVFs. Unfortunately, its onset mechanism remains still unknown. A vascular theory assumed that vertebral collapse might be the direct consequence of a necrotic ischemic process which affects the vertebral bony trabeculae and manifests itself with the so-called IVC (Intravertebral Vacuum Cleft) [13]. On the other hand, a biomechanical theory stated that late vertebral collapse is caused by an impaired healing of the fracture which cause a non-union and a segmental instability of the affected vertebrae with an utter worsening of the damage [14]. A common ground between the vascular and biomechanical theories might be that the vertebral collapse begins with the IVC sign that may represent a trabecular defect caused by the fracture, which subsequently expands from the anterior wall of the vertebral body. This evolution is helped by factors that impair the healing process such as the lack of blood supply, cells and growth factors. Therefore, an important instability creates across the entire trabecular thread which supports the vertebral body. Contemporary, both the forces that weigh normally on the compromised structure and the continuous dynamic stress lead to the progression of vertebral collapse [15].

i junction is the most affected level by fractures: the thoracic spine is linked to the sternum and the rib cage, whose make this region stiff, while lumbar spine bears a greater static and dynamic load and its flexibility increase gradually as the distance to the rib cage increase. These factors contribute to the significant worsening of the vertebral collapse in this region, compared to the other levels.

“Swelling” and “bow shaped” fracture types tend to collapse more than the others as these might involve the anterior but also the middle column, following the Denis et al. [16] three column theory. Middle column is responsible of vertebral stability and represent a high risk factor for vertebral collapse and pseudoarthrosis. Besides, the “swelling” type might be related to a damage of the arteries that supply the vertebral body, causing a necrotic ischemic process with edema, which is responsible of the bulging area noticeable on the anterior wall [1].

Clinical Impact of the Result of the Study

The study highlighted that the progression of vertebral collapse in patients whose fractures were due to an accidental fall was smaller than those whose fractures were not related to a trauma. The difference was not significant and paradoxical at first sight, but it's conceivable that the no trauma fractures might have occurred in strongly compromised vertebrae which led to further collapse.

MRI sequences are often used in the clinical routine; in STIR sequences the “linear black area” might represent a widespread damage of the bone and the trabeculae: its linear shape causes a strong structural instability which interferes with the healing process and lead to a progression of vertebral collapse.

The onset of complications and the failure of conservative treatment are strongly associated with the worsening of patients' clinical status, which are forced to make further use of analgesics and rehabilitative interventions. As Lee et al. [17] stated, osteoporotic fractures will probably remain prevalent and the only solution to the problem is to prevent the excessive occurrence and avoid complications. If avoiding complications is important, a key point is to determine the prognosis of every fracture and evaluate the risk factors that may lead to conservative treatment failure.

Algorithm for Diagnosis and Treatment

In our center, a fresh osteoporotic vertebral fracture diagnosed in DEA which shows none of the above mentioned risk factors is treated conservatively with a bed rest period, pain control with analgesics, bracing, bisphosphonates, radiographic follow-up at 30 days and early rehabilitation. Lot of studies demonstrated that bracing is not useful for prevention of further vertebral collapse, but its analgesic effect makes it a strong pillar in conservative treatment, combined with an early rehabilitation.

If the fracture occur in the i-lumbar level, if it is a “swelled” or “bow shaped” type, or it is A3 or A4 according to AO/OTA classification, the radiographic follow-up is more strict, with the possibility of a further CT o MRI diagnostic at 20 days. In some case which multiple risk factors are noticeable at the first examination, then a TC or MRI are usually performed directly in the DEA. If the i MRI shows a fracture with middle column involvement, a linear black signal in STIR sequences, a T1WI Total type fracture or a T2WI Hypointense-wide-type, then the surgical procedure is discussed: the fracture might be treated with mini-invasive i preferably with stent procedure and, in some cases, with i screws stabilization.

Conclusion

Thoraco-lumbar fractures, swelling and bow shaped fracture and the STIR MR “linear black area” can be considered negative prognostic factors for the failure of the conservative treatment

and the onset of complications such as prolonged back pain, hyperkyphotic deformity and neurologic deficits. Non-conservative treatment must be taken in consideration in the presence of one or more they discussed factors.

Conflict of Interest Statement

The work has not been published before in any language, is not being considered for publication elsewhere, and has been read and approved by all authors. Each author contributed significantly to one or more aspects of the study. No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article. There are no conflicts of interest around this study.

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