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Importance of the relationship between BMD and disc degeneration in the lumbar spine in the elderly

“Now that we are clear about the reverse relationship between osteoporosis and osteoarthritis of the spine, if the molecular cause leading to this reverse relationship were known, new treatment options for both conditions might emerge.”

Spondylosis & osteoporosis

Degeneration is a fact of life. The spine, being the major weight-bearing pillar of the human body, will naturally give prominent manifestations of degeneration with aging. Loss of bone minerals is another sign of advancing age and the slowing of physical activities. Epidemiological studies in the past years have shown the prevalence of lumbar spondylosis with increasing age, particularly affecting those with a high working demand on mechanical stress. The intervertebral discs are structurally designed as shock-absorbing units to slow down the degenerative processes and are, therefore, very much affected by degeneration [1]. It has long been known that intervertebral discs lose their central fluid contents with aging, resulting in shrinkage and loss of height [2].

Osteoporosis is also a pathological feature of aging. Questions we must ask are: how is the spine being affected; what are the changes in the vertebral bodies and intervertebral discs [2].

The morphological changes of the osteoporotic spine include a gradual loss of vertical length because of microfractures of the vertebral bodies; deformities may occur if more severe fractures exist. The osteoporotic spine does not behave uniformly in response to the declining strength of the supporting vertebral bodies, as BMD decreases. Rather, a number of risk factors affect different patterns of behavior [KWOK AWL, LEUNG CS, LEUNG PC: THE PREVALENCE OF VERTEBRAL FRACTURE IN ASIAN MEN AND WOMEN: COMPARISON BETWEEN HONG KONG, THAILAND, INDONESIA AND JAPAN, SUBMITTED] [3].

In a study looking at the prevalence of vertebral fractures (loss of height) among Asians, which included Chinese, Korean, Indonesian and Japanese subjects, it was found that the risk factors included low BMD, maternal history of osteoporosis, older age, defective physical ability

and the presence of cataracts [4]. In this study the intervertebral discs were not assessed. One additional point of interest could have been studied: whether intervertebral discs of the elderly people reported had shrinking heights.

A number of studies exploring the identification of risk factors in relation to osteoporotic fractures of the spine were available in the current literature. None of these studies were particularly focused on the intervertebral discs [5–8].

In fact, orthopedic surgeons have long since noted that although spondylosis and osteoporosis of the spine are both degenerative pathologies, they do not coexist together in the same patient. This practical observation has not been taken seriously by other experts on osteoporosis, although as early as 1991 and 1996, reports on such a relationship between lumbar spondylosis and osteoporosis were already available. In recent years, more clinical studies have been completed on the investigation of the relationship between the degenerative and osteoporotic spine and the morphology of the intervertebral discs.

Verstraeten and van Ermen observed that osteoarthritis retarded the development of osteoporosis in 1991 [9]. Margulies and Payzer made similar observations on the lumbar spine [10]. In 2003, Dequeker and Miyakoshi both reported clinical and research evidence of the inverse relationship between the degenerative and the osteoporotic spine [11,12]. The BMD changes (increases) of the spine in relation to degenerative changes in elderly women were studied by Muraki and Yamamoto in Japan in 2004 and the reverse relationship was again observed [13].

There should be little doubt today that degenerative changes in the spine slows down the development of osteoporosis and the BMD is also better maintained.

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Osteoporosis & intervertebral discs

Orthopedic surgeons, for many years, have also observed that for the severely collapsed vertebral bodies caused by osteoporosis, the intervertebral discs adjacent to the affected vertebral bodies, tend to occupy a wider space radiologically.

In 2001, we completed a survey on the morphological changes in the spine of elderly Chinese women and found that a shortening of the vertebral bodies coexisted with a widening of the intervertebral discs.

“...using MRI to detect disc degeneration in relation to BMD in elderly subjects ... females were found to have more severe disc degeneration than males; lower BMD was associated with less severe disc degeneration.”

Enlarged intervertebral discs assumingly, could be due to breakage of the end plates of the vertebral bodies, leaving vacant spaces to be filled, but why should the disc, which normally dries up and shrinks with age, expand instead? [14,15] This phenomenon has not been explained but increasing interests are mounting. In 1998, Harada studied the relationship between BMD and intervertebral discs and observed decreasing heights with increasing BMD [2]. In 2005, Baron reported disc changes in treated and untreated overweight postmenopausal women [16]. Pye and Reid did the same study on men and women with different values of BMD. The observation was that wider disc spaces accompanied low BMD [17]. In 2007, we reported a modified grading system for lumbar disc degeneration in elderly subjects [18]. We used this grading system to estimate, using MRI, the volume of vertebral bodies and discs, which were observed to decrease with decreasing BMD: the vertebral bodies strictly obeyed this principle while the intervertebral disc behaved less impressively. In fact, when a marked decrease in vertebral heights occurred, the disc inbetween would even expand [19].

Another study was performed using MRI to detect disc degeneration in relation to BMD in elderly subjects. Among 196 females and 163 males, females were found to have more severe disc degeneration than males; lower BMD was associated with less severe disc degeneration [20].

Clinical implications

Now that we are clear about the reverse relationship between osteoporosis and osteoarthritis of the spine, if the molecular cause leading to this reverse relationship were known, new treatment options for both conditions might emerge. Our earlier observations showed that decreasing spinal BMD has a direct influence on the decline in blood supply to the bone, and indicated that osteoporosis could involve complex molecular changes [21]. The higher contents of fatty tissues within the vertebral bodies in the osteoporotic spine further support this assumption and the need for further research [22].

With regard to the behavior of the intervertebral disc in spinal osteoporosis, are there clinical implications?

First, to observe the progress of the osteoporotic spine and to comment on the prognosis, it is important to include an analysis of the intervertebral discs. The more changes in the discs, the more collapses of the vertebral bodies that may be expected. Conversely, the expanded discs should have positive effects on the maintenance of the height of the individual and might also have symptom-relieving effects.

Second, now that vertebroplasty and kyphoplasty are becoming more popular, surgeons should be aware that not only do the long-term effects of the minimally invasive procedures remain uncertain [23,24], but that the morphology of the intervertebral discs may have influences on the behavior of the adjacent vertebral bodies that will be facing the stress-riser challenge of the hardened vertebrae after cement injection.

Third, surgeons attempting to perform open surgery on the osteoporotic spine should be aware of the bizarre morphology of the intervertebral discs: some of them will have undergone the usual degenerative changes while others could be less affected and might even have expanded. Without this awareness, surgeons might not be able to insert implants accurately.

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