The Surgical Treatment of the Osteoporotic Vertebral Compression Fracture in the Elderly Patients with the Spinal Instrumentation

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The study was to present the results of the surgical treatment using the spinal instrumentation toe resolve the osteoporotic vertebral compression fracture in the elderly patients having the clinical symptoms of pain and the neurological compromise.

Sixty elderly patients who underwent the surgical treatment of the osteoporotic vertebral compression fracture were retrospectively reviewed. Their average age was 72 years; the range was 60-90. The average follow-up period for these patients was 4.2 years; the range was 3-7. Twenty-four patients were performed by the posterior stabilization enhanced by the pedicle screws and rods with the transpedicular bone grafting. Thirty-two patients were performed by the anterior corpectomy with the interbody fusion and the anterior spinal instrumentation. Four patients were performed by two-step surgical treatment: firstly the posterior stabilization enhanced by pedicle screws and rods, and finally, the anterior corpectomy with the interbody fusion.

The sagittal Cobb angle and the back pain were improved in all patients. The neurological deficits were improved in 14 patients out of the 16 patients. Twelve patients had the post operative complications: late implants loosening in 5 patients, subcutaneous wound infections in 4 patients, painful neuromas at thoracic cage in 2 patients and incisional hernia in one patient.

Although the surgical treatment with spinal implants in the osteoporotic compression fracture was performed in the selected patients, the complication rate was still high, i.e. twenty percent. All of them, nevertheless, were not the mortal complications. The anterior column support could maintain the sagittal alignment better than the posterior spinal fusion alone in the long-term follow up period while the VAS of pain was improved in the similar results.

Keywords: *Bone screws, Complications, Fractures, compression, Instrumentation, Lumbar vertebrae, Osteoporosis, Neurosurgical procedures, Orthopedic fixation devices, Spinal fractures*

J Med Assoc Thai 2009; 92 (Suppl 5): S109-15
Full text. e-Journal: *http://www.mat.or.th/journal*

The osteoporotic vertebral compression fracture is the most common fracture in osteoporotic fracture. At present, the population gains the increasing longevity, more patients; consequently, seek the treatment for the osteoporotic vertebral fracture. In the United States, 700,000 vertebral compression fractures occur annually[1]. The osteoporotic vertebral compression fracture cases in Thailand are 19.8-24.7% and 4.6% in the elderly of Thai women and in the Thai men population respectively[2-4]. This result plays a major role in the development and the progression of adult spine deformities[5]. The patients mostly have a history of minor injuries, physical exertion, lifting, bending and climbing stairs. Forty-three percents of the patients who have hip fracture also have the osteoporotic vertebral compression fracture. The

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patients can have back pain, loss of body height, progressive kyphosis and neurological deficit. The adverse effects of the osteoporotic fracture are likely to increase in the future with the growing number of the elderly Thai population. The treatment of the osteoporotic vertebral compression fracture can be non-surgery such as bed rest, oral medication and orthrosis. The minimal invasive spinal surgery such as vertebroplasty[6-8], kyphoplasty[7,9] or even the standard technique using the open reduction with the internal fixation was recommended in the selected cases[10,11]. The selected treatment depends on many factors such as age, neurological deficit, underlying disease, surgical preference, care team, patients' constraints. The purpose of this study is to present the results of the surgical treatment with the spinal instrumentation of the osteoporotic vertebral compression fracture in the elderly patients with the clinical symptoms of intractable back pain, back pain with radiculopathy and neurological deficit due to the neurological compromise.

Material and Method

This retrospective study was conducted to evaluate 60 patients surgically treated for the osteoporotic vertebral compression fracture from 1996 to 2003 at Department of Orthopedic Surgery, Faculty of medicine, Siriraj Hospital, Mahidol University, Bangkok. All of elderly patients had painful vertebral fracture according to the minor injury such as lifting, sitting hastily, standing rapidly or slipping and falling down on the buttock.

The patient's age, gender and the method of treatment were recorded from the charts. All patients were followed up for at least three years after the surgery. The clinical symptoms and radiographic findings were evaluated.

Assessment

The outcome was assessed by clinical analysis and radiographs. The clinical outcome was assessed by means of a standardized self-administered questionnaire. The assessment symptoms were pain, motor weakness in lower extremities. Pain was rated on 100-mm visual analog scale (VAS), *i.e.* from the level of discomfort to the unbearable pain. All measures were asked before and after surgery in 3rd months, 6th months and in every 6th-12th month subsequently.

The radiographic outcome was accessed by the measurement of the sagittal angle on lateral film standing radiograph. The pre-operative, post-operative and finial follow-up sagittal angle between T12 and L2 was determined by Cobb's method[12].

Results

In this study, 60 patients were reviewed. There were 40 females (66%) and 20 males (33%) with the average age of 72 years (range 60-90 years). The range of age was shown in Table 1. The average follow-up period for these patients was 4.2 years (range 3-6 years). The study patients were classified into Groups A, B, and C based on the method of intervention (Table 2). The level of vertebral fracture of each group was shown in Table 3. Group A was treated by using posterior stabilization, pedicle screws and rods fixation enhanced by the transpedicular bone graft at the fracture vertebral body. Group B was treated by using the anterior corpectomy, interbody fusion and anterior spinal instrumentation. Group C was treated by two-step technique: the posterior stabilization with pedicle screws and rods, and the anterior corpectomy with interbody fusion. The types of fractures were classified in Table 4.

Table 1. Age of the incidences

Age	Number of patients	%
60-70	30	50.0
71-80	26	43.3
81-90	4	6.7
Total	60	100.0

Table 2. Gender of the incidences

Group	Number of patients	Female	Male
A	24	16	8
B	32	20	12
C	4	3	1
Total	60	39	21

Table 3. Level of the fractures

Level of spine	T11	T12	L1	L2	Multilevel
Group A	3	7	10	2	2
Group B	3	10	15	4	0
Group C	1	2	1	0	0
Total	7	19	26	6	2

The clinical symptoms causing the patients to seek the medical attention were intractable back pain, leg pain and neurological deficit; these were shown in Table 5 and 6.

The VAS analog scale of pain and the follow-up period after the surgery displaying in years were shown in Fig. 1.

Group C was excluded for statistic analysis due to limitation in the number of patients. For Group A and B, the average pre-operative sagittal angle (T12-L2) was 42.2° kyphosis (range, 22° to 55°) and in the first month of the follow-up, the average post operative sagittal angle was 14.9° kyphosis (range, 5° to 35°). The average operative correction was 27.3°. In the 6th month, 1st year, 2nd year, 3rd year and 4th year of the follow-up, the average post operative sagittal angle were 16.3°, 20.9°, 22.9° and 23.7° respectively (Fig. 2A). In the final year of the follow-up, the average post operative sagittal angle was 24.4° (range, 15°-35°).

Table 4. Types of the fractures

	Type	Patients	%
A	Wedge	16	26.70
B	Flattening	19	31.70
C	Non-union	13	21.70
D	Crush	6	10.00
E	Superior end plate	4	6.70
F	Multiple collapse	2	3.10

Table 5. Neurological involvement of the pre- and post-operations

	Pre-operation	Post-operation
Frankle grade	B (4)	B (2)
		C (1)
		D (1)
	C (12)	D (2)
		E (10)

Table 6. Number of the cases and the clinical symptoms

	Cases	Improved case
Intractable back pain	48 (80.00%)	45
Leg pain	9 (11.25%)	7
Neurological deficits	14 (23.33%)	12

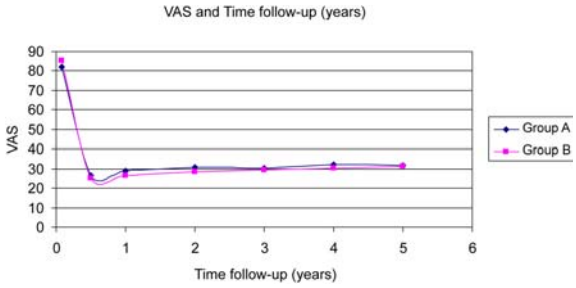

Fig. 1 VAS (visual analog scale) and the year follow-up of the post operation

In Group A (Table 2, 3), the average pre-operative sagittal angle (T12-L2) was 40.3° kyphosis (range, 22° to 50°) and in the first month of the follow-up, the average post-operative sagittal angle was 15.2° kyphosis (range, 5° to 30°). The average operative correction was 25.1°. Then in the 6th month, 1st year, 2nd year, 3rd year and 4th year of the follow-up, the average post operative sagittal angle were 17.4°, 20.9°, 23° and 23.7°, respectively, (Fig. 2B). In the final year of the follow-up, the average post operative sagittal angle was 24.9° (range, 15°-35°).

In Group B (Table 2, 3), the average pre-operative sagittal angle (T12-L2) was 44.2° kyphosis (range, 35° to 55°) and in the first month of the follow-up, the average post operative sagittal angle was 14.7° kyphosis (range, 5° to 35°). The average operative correction was 29.5°. Then in the 6th month, 1st year, 2nd year, 3rd year and 4th year of the follow-up, the average postoperative sagittal angle were 15.3°, 21°, 22.8° and 23.4°, respectively, (Fig. 2B). In the final year of the follow-up, the average post operative sagittal angle was 24° (range, 17°-30°).

The complication rate was found to be 20% (12 patients of both Group A and B). No complication was found in Group C. Five patients in Group A had the symptomatic implant loosening. Two patients in Group A and two patients in Group B had the subcutaneous wound infection. Two patients in Group B had the painful neruoma in thoracic cage. One patient in Group B had the incision hernia.

Data analysis

The Wilcoxon sign-rank test was used to evaluate the differences of the pre-operative sagittal angle: 1st month postoperative sagittal angle and the last follow-up of the sagittal angle of the same group. The Mann-Whitney U test was used to compare the pre-operative sagittal angle: the first month

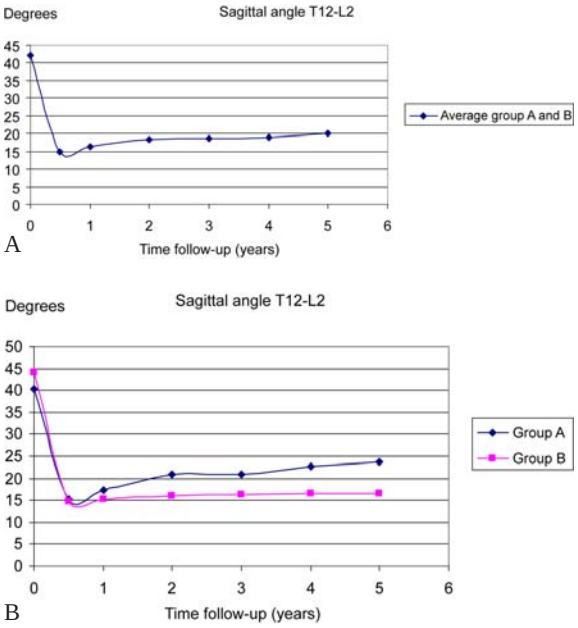

Fig. 2 Follow-up the sagittal Cobb angle T12-L2 after the surgery of the average Group A and B

post-operative, and the last follow-up postoperative sagittal angle and the VAS of pain improvement between Groups A and B. Group C was excluded due to the limited number of the patients.

In Group A, there were statistically significant differences of the preoperative sagittal angle and 1st month postoperative sagittal angle ($p \leq 0.05$). There also were statistically significant differences of 1st month postoperative sagittal angle and the last follow-up of the sagittal angle of Group A ($p \leq 0.05$).

In Group B, there were statistically significant differences of the pre-operative sagittal angle and 1st month post operative sagittal angle ($p \leq 0.05$). On the other hand, there were no statistically significant differences of 1st month post operative sagittal angle and the last follow-up of the sagittal angle ($p > 0.05$).

When comparing the pre-operative outcomes, 1st month post operative sagittal angle and the VAS between Group A and B, there were no statistically significant differences ($p > 0.05$) whereas there were statistically significant differences of the last follow-up of the sagittal angle of Group A and B ($p \leq 0.05$)

Discussion

During the past decades, there were numerous studies[13-15] presenting the effectiveness of the treatment of osteoporotic compression fracture via the non-surgical approaches such as bed rest, orthosis[16], oral[17], intravenous[18] or nasal medication[19]. There were also a large number of studies[6-9] showing the treatments of the osteoporotic compression fracture via the minimal invasive spinal surgery, for example, vertebroplasty[6-8], kyphoplasty[7,9]. However, more invasive surgical treatment via the open reduction with the spinal instrumentation is rather few as the complications related with the spinal instrumentation in the osteoporotic bone and morbidity and mortality can occur in the elderly population.

Generally, the major reconstructive spinal surgery in the elderly is uncommon due to a high rate of major complications that are age-related. Many osteoporosis patients often have significant co-morbidities such as heart disease, respiratory disease, diabetes and high blood pressure. The morbidity increases significantly if two or more co-morbidities are present. The patients in this study were selected and obtained the surgical treatment in the condition that they had only minor comorbidites, for instance, mild hypertension and mild diabetes. The complication rate was 20% in this study; one fourth of it was in Group A. The complication in Group A was the symptomatic implant loosening while Group B had none which might result from the anterior bone grafting that worked as a supporting structure to share loading. The serious complications did not occur because the patients submitted for the surgery were well selected. The bone of the patients in Group A had greatly decreased the mechanical strength. The pedicle screws and rods provided the additional strength to prevent the fixation from failure. There were many custom-made devices to improve the screws fixation and to reduce the implants loads in the osteoporosis patients as a result of the developments of the surgical techniques and in both pedicle screw designs and biologic enhancement such as the increased pedicle screw size[20,21], the conical screws[22,23], the undertapping or self-tapping screws[24], the biologically-enhanced screws or coated screws[25,26], the expandable screws[27], the alternative thread designs, the up-and-in screw orientation[23,28], using alternate points for fixation, including pediculolaminar fixation[29,30], the anterior cortex fixation, the sacral promontory[31] or alar even adding pelvic fixation[32]. Occasionally, the injectable fillers[33,34], the interbody grafting[35] and the adjacent segment augmentation to improve fixation[10] were used. However, the fixation stability in the osteoporotic patients depends more on bone quality than screw

design[36]. In this report, the undertapping[24], the conical screws[8] and the increasing pedicle screw size[20] were performed to obtain better fixation through the bone. Despites selecting these methods, the complication of loosening was still rather high.

Although the opened surgical treatment of the osteoporosis vertebral compression fracture is uncommon, it plays a significant role. The indications of the surgical treatment are the neurological compromise, the late neurological deficit secondary to progressive collapse, the spinal instability, the deformity and spinal stenosis, and the progressive painful fracture not amenable to vertebroplasty or kyphoplasty with the progressive deformity including scoliosis and kyphosis. However, Group A underwent the surgery due to the pain only. The operation was conducted in Group B due to pain and neurological deficits while Group C underwent surgery concerning pain, neurological deficits and the patient's financial problems.

However, most patients had considerable improvement of pain in spite of the under correction. The sagittal angle of Group B was becoming more improved than Group A in the long-term follow-up period according to the anterior support structure. The VAS scores did not correlate to the degree of the deformity correction, but they were related to the adequacy of neural decompression and successful fusion.

Conclusion

The surgical treatment with spinal implants in the osteoporotic vertebral compression fracture should be performed in the selected patients even though the complication was still high (20%). However, all of them were not mortality complications. The sagittal angle in the patients undergoing the anterior interbody fusion with the instrumentation was better than that of the patients treated by posterior stabilization and enhanced by transpeducular bone grafting in the long-term follow-up period. The VAS of pain was similar in both groups.

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การรักษาผู้ป่วยสูงอายุที่มีภาวะกระดูกสันหลังพรุนและหักยุบ โดยการผ่าตัดและยึดตรึงกระดูกสันหลังด้วยโลหะ

จตุพร โชติกวณิชย์, ศัลยพงศ์ สรรพกิจ, ธเนศ วรรธนอภิสิทธิ์, สุรินทร์ ธนพิพัฒนศิริ, เจริญ โชติกวณิชย์

การศึกษาครั้งนี้เป็นการศึกษาย้อนหลัง โดยศึกษาผู้ป่วย 60 ราย ที่มีภาวะกระดูกสันหลังพรุนและหักยุบ และมีอาการเจ็บปวดบริเวณหลังเนื่องจากกระดุกยุบหรือมีปัญหาจากการกดทับของระบบประสาท แล้วได้รับการรักษาด้วยการผ่าตัดและยึดตรึงกระดูกสันหลังด้วยโลหะ โดยระยะเวลาติดตามเฉลี่ย 4.2 ปี (3-7 ปี) อายุผู้ป่วยเฉลี่ยคือ 72 ปี (60-90 ปี) ผู้ป่วย 24 รายได้รับการผ่าตัดและยึดตรึงกระดูกทางด้านหลัง ผู้ป่วย 32 ราย ได้รับการผ่าตัดและยึดตรึงกระดูกทางด้านหน้า ผู้ป่วย 4 ราย ได้รับการผ่าตัดยึดตรึงกระดูกทางด้านหลัง และทำการผ่าตัดทางด้านหน้าเพื่อเอากระดูกที่ทับไขสันหลังออก

จากการศึกษาพบว่า ผู้ป่วยทุกรายภายหลังจากการติดตามผล มีอาการปวดบริเวณหลังน้อยลงและหลังโก่งน้อยลง อย่างไรก็ดี มีภาวะแทรกซ้อนเกิดขึ้นค่อนข้างสูงถึงร้อยละ 20 แต่เป็นภาวะแทรกซ้อนที่ไม่ร้ายแรง เช่นเหล็กที่ยึดตรึงกระดูกโลหะทางด้านหลังมีการหลวม แต่ไม่พบการหลวมของโลหะจากการผ่าตัดและยึดตรึงกระดูกทางด้านหน้า ปัจจัยหนึ่งอาจเนื่องจากการผ่าตัดทางด้านหน้ามีการเสริมกระดูกทางด้านหน้าเพื่อค้ำจุนไว้ และพบหลังโก่งน้อยกว่า การผ่าตัดและยึดตรึงกระดูกทางด้านหลังเพียงอย่างเดียว