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KYPHOPLASTY IN THE TREATMENT OF PAINFUL OSTEOPOROTIC VERTEBRAL COMPRESSION FRACTURES

AĞRILI OSTEOPOROTİK VERTEBRA KOMPRESYON KIRIKLARINDA KİFOPLASTİ

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SUMMARY:

Introduction: The treatment algorithm for osteoporotic vertebral compression fractures (OVCFs) has completely transformed with the inclusion of kyphoplasty in the surgical routine. The objective of this work is to review the clinical and radiological outcomes of kyphoplasty in the treatment of OVCF.

Materials & Methods: 55 patients suffering from 70 OVCFs were treated with kyphoplasty between 2002 and 2011. Anterior, middle and posterior height losses and kyphosis changes were radiologically investigated, and the VAS and ASIA scores were reviewed.

Results: The mean duration of the phenomena was 69.3 days. The mean VAS scores were found to be 7.2 ± 0.8 preoperatively, and 1.2 ± 1.1 postoperatively ($p<0.05$). The vertebral body height restoration was found to be 39.4 ± 25.6%, 50.7 ± 23.2% and 46.1 ± 34.8%, in the anterior, middle and posterior parts of the vertebrae, respectively ($p<0.05$). Cement leakage was observed at 16 (22.8%) levels following PMMA injection, and a significant relationship was found between cement leakage and the amount of cement applied ($p<0.05$). Acute fractures showed significantly better vertebral body height restoration than subacute cases ($p<0.05$).

Conclusion: Kyphoplasty is an effective treatment for OVCF. A bilateral approach was not superior to a unilateral approach in terms of the management of pain. Early kyphoplasty is one of the most important factors affecting restoration. Aggressive cement injection should be avoided.

Key words: Kyphoplasty, osteoporotic vertebral fractures, surgical treatment, complications

Level of evidence: Retrospective clinical study, Level III

ÖZET:

Giriş: Kifoplasti osteoporotik vertebra kompresyon fraktürlerinde (OVCF) cerrahi rutine girmiş bir tedavi algoritmasıdır. Bu çalışmanın amacı kifoplasti uygulanarak tedavi edilen OVCF'de, kifoplasti ile elde edilen klinik ve radyolojik sonuçları gözden geçirmektir.

Materyal-Metot: 2002-2011 döneminde 70 ağrılı OVCF olan 55 hastaya kifoplasti uygulaması yapılmıştır (yaş; 69.7 ± 6.3, 38 kadın). Radyolojik olarak vertebra ön, orta ve arka yükseklik kayıpları ile kifoz değişimi değerlendirilmiş, klinik bulgular için VAS ve ASİA skorları kullanılmıştır.

Sonuçlar: Olguların ortalama semptom süresi 69.3 gün olup, preoperatif ortalama VAS 7.2 ± 0.8, postoperatif 1.2±1.1 olarak değerlendirildi ($p<0.05$). Vertebra korpus ön yükseklik restorasyonu % 39.4 ± 25.6, orta yükseklik restorasyonu % 50.7 ± 23.2, arka duvar restorasyonu % 46.1 ± 34.8 olarak ölçüldü ($p<0.05$). PMMA enjeksiyonu sonrası 16 (% 22.8) seviyede sement sızıntısı gerçekleşmiş olup, verilen semen miktarı ile sement sızıntısı arasında anlamlı bir ilişki bulundu ($p<0.05$). Akut olgularda uygulanan kifoplasti işlemi ile elde edilen VBHR değeri daha yüksekti ($p<0.05$)

Sonuç: Kifoplasti OVCF'de etkili bir tedavi şeklidir. Kullanılacak sement miktarı uygulanacak seviye ve çökme düzeyine göre sınırlı olmalıdır. Ağrı amacıyla yapılan olgularda bilateral yaklaşımın unilaterale üstünlüğü yoktur. Restorasyon düzeyini etkileyen en önemli faktör erken kifoplasti uygulamasıdır.

Anahtar kelimeler: Kifoplasti, osteoporotik vertebra kırığın, cerrahi tedavi, komplikasyonlar

Kanıt düzeyi: Retrospektif klinik çalışma, Düzey III

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INTRODUCTION:

Osteoporotic vertebral compression fractures (OVCFs) are one of the most common complications observed in patients suffering from osteoporosis. It has been estimated that approximately 1.5 million osteoporotic vertebral compression fracture cases are observed annually in the U.S.[23]. Approximately, more than 700,000 patients suffering symptomatic fractures apply for medical treatment, and 20% of them are hospitalized while 20% resort to physical treatment centers[30]. More than 4% of patients with osteoporotic vertebral fractures suffer functional loss, and 1.9% of these patients end up requiring nursing[12,34].

Patients with OVCF suffer a reduction in performance in their daily life, their psychological performances erode and their daily actions are limited by the fear of new fractures. Patients with OVCF have a higher death rate compared to other members of the same age cohort[14]. Typical patient symptoms in an OVCF clinic consist of insidious pain, soft tissue tenderness and radiological findings. Rarely, neurological deficits may develop[31].

Corpus height loss, segmental instability, radicular findings and kyphotic deformities may occur with osteoporotic vertebral fractures[31]. Segmental instrumentation, a major treatment applicable to vertebral fractures, carries a serious complication risk, taking into account the age and clinical status of the patients[8,9]. Kyphoplasty is the most important invasive surgical treatment applicable for OVCF cases.

The purpose of this study is to compare preoperative and postoperative radiological and clinical results, to enable safer and more effective application of kyphoplasty in cases of osteoporosis.

MATERIALS AND METHODS:

The charts of 55 patients with painful OVCF were reviewed. A kyphoplasty procedure was performed on 70 fractures of the 55 cases under sedoanalgesia. The selection criteria included painful OVCF secondary to primary and secondary osteoporosis. Patients with additional spinal disorders were excluded from the study.

Preoperative and postoperative clinical and radiological parameters were reviewed (Table-1). All patients were contacted before completion of the study.

The pain severity was assessed using the visual analogue scale (VAS). The neurological status was evaluated using the American Spinal Injury Association (ASIA) scale.

The radiological evaluations were performed using plain thoracic and lumbosacral radiographs, and thoracic and lumbar magnetic resonance images (MRI). Flexion-extension radiographs were used to reveal any evidence of fracture mobility (i.e., the presence of expansion of the compression fracture in the extension position).

Table-1. Clinical and radiological parameters (VBHL: vertebral body height loss)

Clinical parameters	Radiological parameters
Age, gender	The number and type of fractures
Symptoms	Anterior, middle, and posterior VBHL
Symptom duration	Vertebral body posterior bone integrity
Pain severity (VAS score)	Evidence of spinal cord compression
Local tenderness	Segmental and vertebral angulation rates
Neurological state score (ASIA)	Thoracic kyphosis and lumbar lordosis

T1, T2 and diffusion MRIs were used to detect the number of fractures, any evidence of spinal cord compression and the presence of an intravertebral cleft, and STIR MRIs were used

to detect any evidence of edema. Postoperative imaging was performed using plain radiographs and spinal computed tomography (CT).

Vertebral body height loss (VBHL), vertebral body height restoration (VBHR), vertebral angle, kyphotic angle, thoracic kyphosis and lumbar lordosis were measured on the plain radiographs. In order to detect the VBHL rate, the expected height of the fractured vertebral body was calculated. The expected height of the fractured vertebral body (D) was accepted as the average of the height of the vertebral bodies above (A) and below (B) the fractured vertebra: $D = (A+B) / 2$[1].

The height of the fractured vertebra (C) was then measured and the VBHL was calculated using the following formula: $VBHL = (D - C/D) \times 100$[2].

The restoration rate of the vertebral body height (VBH) was determined by the following formula: 100 - (postoperative VBH × 100) / preoperative VBH[3].

The vertebral body angle was defined as the angle formed by the intersection of lines parallel to the superior and inferior endplates of the fractured vertebra, and was measured using plain radiographs. The segmental angle was defined as the angle formed by the intersection of a line parallel to the superior endplate of the upper vertebra and a line parallel to the inferior endplate of the lower vertebra.

The thoracic spine kyphosis (T1–12) and the lumbar spine lordosis (L1–5) were also measured on plain radiographs.

The fracture type, vertebral body posterior wall integrity, and evidence of epidural bulging of the vertebral body posterior wall were defined using MRI and CT images. Vertebral body fractures were classified as wedge fractures and biconcave fractures.

For statistical analysis, the values of the preoperative and postoperative VBHL and the kyphotic deformity were statistically compared using the nonparametric Wilcoxon signed rank test. The VAS and cement leakage were statistically compared using a paired nonparametric analysis (Wilcoxon signed rank test). The level of significance was taken as 0.05.

RESULTS:

There were 38 females and 17 males, aged between 53 and 85 (mean 69.7). There were 70 painful OVCFs in 55 cases, including a one-level fracture in 45 cases (75%), a two-level fracture in six cases (10.9%), a three-level fracture in three cases (5.4%) and a four-level fracture in one case (8.7%).

Clinical parameters:

The major symptoms included pain in 55 cases (100%) and neurological deficit in one case (1.8%). The mean symptom duration was 61.5 (range: 7–90) days. The mean preoperative VAS score was 7.5 ± 0.9 (range: 6–9). There was complete and significant pain relief in all cases. The mean postoperative VAS score was 2.8 ± 0.7 (range: 2–5) ($p<0.05$).

The postoperative VAS score was found to be 5 in five cases (9%), 4 in 20 cases (36.3%), 3 in 18 cases (32.7%) and 2 in 12 cases (21.8%). There was a significant difference between the preoperative and postoperative VAS scores ($p<0.05$).

Postoperative pain relief was found to be significant for cases of both thoracic and lumbar OVCFs (p<0.05) (Table-2).

Table-2. Comparison of preoperative and postoperative VAS scores (mean ± SD)

Thoracic		
Preoperative VAS	7.1 ± 0.8	p<0.05
Postoperative VAS	2.9 ± 0.8	
Control VAS	1.1 ± 1.1	
Lumbar		
Preoperative VAS	7.3 ± 0.8	p<0.05
Postoperative VAS	2.8 ± 0.7	
Control VAS	1.3 ± 1.2	
Total		
Preoperative VAS	7.2 ± 0.8	p<0.05
Postoperative VAS	2.8 ± 0.7	
Control VAS	1.2 ± 1.1	

The final VAS scores of the patients were ascertained by a telephone interview. 46 out of the 55 cases could be contacted. The mean final VAS score was found to be 1.2 ± 1.1.

The preoperative ASIA score was found to be D in only one case (2.2%) and E in 44 cases (97.8%). Postoperatively, the ASIA scores did not change.

Radiological parameters:

The vertebral body fractures were classified as a biconcave fracture at 33 (47.1%) levels, and as a wedge fracture at 37 (52.9%) levels. There was no epidural extension at 63 levels (90%), minimal spinal canal violation at six levels (8.5%), and moderate spinal canal violation at one level (1.4%).

The mean preoperative anterior VBHL was found to be 33.6 ± 17.9% in the thoracic vertebrae and 31.4 ± 17.7% in the lumbar vertebrae. The mean preoperative middle VBHL was found to be 32.2 ± 18.8% in the thoracic spine and 34.7 ± 15.1% in the lumbar spine. The mean preoperative posterior VBHL was found to be 11.4 ± 10.3% in the thoracic vertebrae and 13.3 ± 11.7% in the lumbar vertebrae (p<0.05) (Table-3).

While the anterior, middle and posterior VBH restorations in the lumbar vertebrae were found to be 37.6 ± 22.7%, 48.3 ± 24.4% and 45.8 ± 35.3%, respectively, in the thoracic vertebrae they were 42.3 ± 25.5%, 54.6 ± 21.2% and 46.6 ± 34.9%, respectively (Table-4).

The mean preoperative angulation in the thoracic and lumbar vertebrae was measured as 11.9 ± 5.7° (range: 3–25°) and 12.7 ± 6.5° (range: 3–35°), respectively. The mean postoperative angulation in the thoracic and lumbar vertebrae was measured as 6.9 ± 5.1° (range: 0–16°) and 6.2 ± 5.2° (range: 0–21°), respectively (p<0.05) (Table-5).

Assessment of Cement Leakage:

Asymptomatic PMMA leakage was observed at 16 levels (22.8%). The cement leaked to the epidural area at three levels (18.8%), to the upper disc at two levels (12.5%), to the lower intervertebral disc at two levels (12.5%), to the vascular area at one level (6.3%), and to the paravertebral muscles at eight levels (50%).

Table-3. Comparison of the preoperative and postoperative vertebral body height loss (mean ± SD).

	Preoperative VBHL			Postoperative VBHL			p
	Anterior	**Middle**	**Posterior**	**Anterior**	**Middle**	**Posterior**	
Thoracic	33.6 ± 17.9	32.2 ± 18.8	11.4 ± 10.3	18.7 ± 11.8	14.5 ± 11.4	5.4 ± 5.5	
Lumbar	31.4 ± 17.7	34.7 ± 15.1	13.3 ± 11.7	18.8 ± 11.9	18.0 ± 13.0	5.9 ± 6.7	<0.05
Total	32.2 ± 17.7	33.8 ± 16.4	12.6 ± 11.2	18.8 ± 11.8	16.7 ± 12.5	5.7 ± 6.2	

Table-4. Rates of thoracic and lumbar vertebral VBH restoration (mean ± SD)

	VBH Restoration		
	Anterior	**Middle**	**Posterior**
Thoracic	42.3 ± 25.5%	54.6 ± 21.2%	46.6 ± 34.9%
Lumbar	37.6 ± 22.7%	48.3 ± 24.4%	45.8 ± 35.3%
Total	39.4 ± 25.6%	50.7 ± 23.2%	46.1 ± 34.8%

Correlation tests:

There was no correlation between the duration of symptoms and the preoperative VAS score (p>0.05) (Table-6). There was also no correlation between the preoperative VAS score and the preoperative VBHL rate (p>0.05) (Table-7).

There was no significant difference between the preoperative and postoperative VAS scores when patients with or without epidural tumor extension were compared (p>0.05) (Table-8).

Patients with a duration of symptoms of less than 60 days showed a better VBH restoration rate than those with a longer duration of symptoms (p<0.05) (Table-9).

The amount of PMMA injected was 5 cc or less at 23 levels (38.3%), and more than 6 cc at 37 levels (61.7%). There was a correlation between the amount of PMMA injected and cement leakage in the thoracic vertebrae (p<0.05) (Table-10).

There was no correlation between the amount of PMMA injected and pain relief (p>0.05) (Table-11).

There was also no correlation between the amount of injected PMMA and the anterior and middle VBH restoration rate (Table-12).

There was no correlation between the presence of an intravertebral cleft and the VBH restoration rate (p>0.05) (Table-13).

Table-5. Comparison of preoperative and postoperative vertebral body angles

	Vertebral Body Angle			
	Preoperative	**Postoperative**	**Restoration**	**p**
Thoracic	11.9 ± 5.7°	6.9 ± 5.1°	5.0°	
Lumbar	12.7 ± 6.5°	6.2 ± 5.2°	6.5°	
Total	12.4 ± 6.5°	6.5 ± 5.1°	5.9°	<0.05

Table-6. The relationship between symptom duration (days) and VAS score (mean ± SD)

Symptom duration	Preoperative VAS
0–60 (n=42)	7.1 ± 0.7
61 –↑ (n=13)	7.5 ± 0.9
p	>0.05

Table-7. The relationship between preoperative middle VBHL rate and VAS score (mean ± SD)

Preoperative middle VBHL rate	Preoperative VAS
0–25% (n=29)	7.1 ± 0.7
25–↑% (n=41)	7.4 ± 0.8
p	>0.05

Table-8. Comparison of pain relief in patients with and without epidural extension (mean ± SD)

Evidence of epidural tumor extension	Preoperative VAS	Postoperative VAS
No epidural extension (n=63)	7.0 ± 0.7	2.6 ± 0.8
Epidural extension (n=7)	7.3 ± 0.8	2.5 ± 0.5
p	>0.05	>0.05

Table-9. The relationship between symptom duration and VBH restoration rate (mean ± SD)

Evidence of epidural tumor extension	Preoperative VAS	Postoperative VAS
No epidural extension (n=63)	7.0 ± 0.7	2.6 ± 0.8
Epidural extension (n=7)	7.3 ± 0.8	2.5 ± 0.5
p	>0.05	>0.05

Thirty-two levels (31.4%) with OVCF were included in the unilateral kyphoplasty. The levels of leakage of cement were all unilateral, except for one level that underwent a bilateral operation. Cement leakage was seen more often with bilateral vertebral kyphoplasty ($p<0.05$). Pain improvement did not differ significantly when comparing patients who received unilateral or bilateral intervention ($p>0.05$). Bilateral intervention occurred at rates higher than for kyphosis correction ($p<0.05$).

Table-10. Comparison of amount of injected PMMA and the occurrence of cement leakage

	Amount of injected PMMA (n=levels)	Leaked	p
Thoracic	3–5 cc (n=12)	1	<0.05
	5–9 cc (n=10)	7	
Lumbar	3–5 cc (n=11)	1	<0.05
	5–9 cc (n=37)	7	
Total	3–5 cc (n=23)	2	<0.05
	5–9 cc (n=47)	14	

Table-11. The relationship between pain relief and amount of injected PMMA (preop: preoperative, postop: postoperative), (mean ± SD)

Amount of Injected PMMA	Lumbar		Thoracic		Total	
	Preop VAS	Postop VAS	Preop VAS	Postop VAS	Preop VAS	Postop VAS
3–5 cc	7.4 ± 1.0	3.8 ± 0.4	7.4 ± 0.6	3.7 ± 0.9	7.4 ± 0.8	3.2 ± 0.7
5–9 cc p	7.2 ± 0.5	3.1 ± 0.7 >0.05	6.8 ± 0.8	3.1 ± 0.8 >0.05	7.1 ± 0.7	2.5 ± 0.6 >0.05

Table-12. The relationship between amount of injected PMMA and VBH restoration rate, as well as between amount of injected PMMA and kyphosis correction rate (mean ± SD)

	VBH anterior wall Restoration	VBH middle Restoration	p
Thoracic			
3–5 cc	41.5 ± 32.9	49.0 ± 17.8	>0.05
5 cc ↑	39.9 ± 29.7	62.6 ± 24.0	
Lumbar			
3–5 cc	32.9 ± 28.5	45.3 ± 28.6	>0.05
5 cc ↑	35.1 ± 22.6	47.7 ± 24.3	

Table-13. The relationship between the presence of the vertebral cleft and VBH restoration rate (mean ± SD)

Cleft	VBH anterior wall restoration	VBH middle restoration	p
With cleft (n=51)	30.8 ± 17.1%	33.3 ± 16.7%	>0.05
No cleft (n=19)	36.5 ± 21.6%	36.9 ± 14.7%	

DISCUSSION:

Osteoporosis is a systemic illness identified by a decrease in bone density. Vertebral compression fractures may develop as a result of this decrease in bone density. The most common symptom of OVCF is acute lumbago. Analgesics, rest care and orthotics can be used for treatment.

Surgical instrumentation and decompression can be used in cases of advanced compression fracture with pressure on neural structures. Additional health problems and the need for long-term rest complicate the application of major surgery[23,30,34].

Kyphoplasty, in a minimally invasive approach accompanied by sedoanalgesia, provides an improvement in segmental kyphosis in OVCF patients through pain relief and height restoration of the vertebral corpus. With this technique, early mobilization, low complication rates and no need for general anesthesia reduce the risks. Restored by inflating with bilateral balloon kyphoplasty and injecting PMMA[7]. As a result, a height restoration of 76 ± 23% and a kyphosis angle correction of 8.7 ± 5.5° were observed. These improvements were more robustly provided for lumbar vertebral fractures; however, the redundancy of the ligamentous, muscular and bone structures that hold the vertebrae can negatively affect this kyphosis improvement in thoracic fractures[7,32]. It has been recorded that more successful restoration results were obtained with multi-level applications in cases of multiple thoracic fractures[26].

The scope of kyphoplasty is to secure an 8–10% decrease in kyphosis together with hyperextension, in a prone position on the operating table. This kyphotic improvement is obtained as a result of inflation of a kyphoplasty balloon, and the injection of cement renders it permanent. However, this value remains below the initial correction obtained. In particular, sagittal overload following the patient's mobilization increases this gain[32]. It has also been recorded.

Improvement in Pain:

Research on the vertebroplasty and kyphoplasty techniques for patients with OVCF has shown that both applications provide an improvement in pain[9-11,21]. A 75–100% improvement in pain has been observed in various studies[2,3,15,28]. This has been calculated by the rate of patients enjoying preoperative and postoperative VAS recovery. One study showed that pain was completely relieved in 78% of cases[20]. In our study, pain was immediately and decisively relieved for all patients (100%) who received kyphoplasty.

Clinical and Radiological Results:

Kyphoplasty has been shown in many studies to restore the vertebral corpus and correct the kyphosis angle. In an experimental study by Gaitanis et al., fabricated wedge compression fractures were in the literature that a leveled application is required in order to achieve an effective correction in kyphosis angle with kyphoplasty[29]. While there was 5.9° kyphosis correction in the patients who received surgery in our study, in agreement with the literature, this improvement is observed at a higher level in cases of lumbar fractures. Considering the vertebral height increase, the value for the middle column was 50.7 ± 23.2%, and for the anterior column it was 39.4 ± 25.6%. The higher increase in the middle column compared to the anterior column appears to be different to the results of other published studies[7,16,32,36]. However, this is also related to the experience of the surgeon and the surgical technique.

Another factor that affects the surgical result is the choice between unilateral and bilateral applications. In the majority of other published studies, comparison was made between unilaterally and bilaterally applied phenomena. The pain improvement indicated that there is no significant difference between vertebral corpus height restoration and kyphosis correction. Taking into consideration the reduced surgical duration and the risk of cement leakage and applied radiation, a unilateral application is recorded to be sufficient[15,25,37]. In accordance with the comparison made between the levels which underwent unilateral kyphoplasty or bilateral kyphoplasty in our study, no significant difference was observed in terms of the improvement in pain. In cases where bilateral kyphoplasty was used, better results were obtained for the kyphosis correction. However, kyphoplasty was applied at only one of the levels where cement leakage occurred, while at all other levels with leakage, bilateral surgeries were carried out.

No significant relationship was observed between the applied cement, corpus height restoration and kyphosis correction when pain is considered. Pain was the most important symptom of the patients who underwent kyphoplasty, while it was other parameters for the other patients. Therefore, the amount of cement and the levels of restoration did not appear to be determinant factors in our study. Although the disturbed load balance and kyphosis due to OVCF have been argued to be causes of pain, the relationship between restoration as a result of kyphoplasty and pain has not been discussed in the literature[29,32].

No statistically significant differences were found between the restoration ratios of vertebrae involving clefts (n=51, 72.8%) and vertebrae without clefts. This agrees with previous studies, which have also found no difference.

Complications:

The most common complication of kyphoplasty is cement leakage. This may result in pathologies arising from leakage of cement out of the corpus, or toxic and allergenic reactions caused by the cement[1,11,24,35]. Cement leakage into the epidural or intradural hole may cause complications, and pulmonary embolism may occur as a result of the cement mixing into the vascular circulation system[8,18,19,28,33].

When compared with vertebroplasty, the risk of cement leakage decreases significantly in kyphoplasty[5,22,33]. Eck et al. compared vertebroplasty and kyphoplasty phenomena in a meta-analysis study. Out of 3034 kyphoplasty applications, cement leakage was observed in 213 cases (7.0%), while the ratio was 19.7% in vertebroplasty surgeries. Additionally, symptomatic cement leakage was 1.6% in vertebroplasty and 0.3% in kyphoplasty[5]. In similar meta-analysis studies, it was found to be around 8–9%, while in VP applications this ratio was observed to be around 40–41% [13,27,33].

In our study, cement leakage occurred in 16 cases (22.8%). No neurological deficits occurred. One of the most important advantages of kyphoplasty is that the symptomatic cement leakage rate is very low. In cases where cement leaks into the disc hole, kyphoplasty should also be applied to the adjacent level[22].

Although pulmonary embolism, a serious complication that may arise from cement leakage with kyphoplasty, can be observed radiologically at a ratio of 0.6%, its clinical reflection is 0.01%[13].

It has been suggested that kyphoplasty subsequently increases the incidence of new fractures. These fractures can be adjacent segment fractures or distant level fractures. It has been recorded that, on injection of cement, the presence of a cleft in the adjacent vertebra or cement leakage into the disc hole increases the risk of fractures in the adjacent segment for the first two months following surgery[6,18,22]. There are studies that have suggested that the necessary restoration and improvement in pain is assured in cases where the cement applied corresponds to 15% of the volume of the corpus[17]. Conversely, Dalbayrak et al. suggested that there is no relationship between the amount of cement and the improvement in pain, but increasing the amount of cement creates a ground for complications by increasing the risk of leakage[4]. No re-fractures occurred in our study during the two-year follow-up period. In four cases, non-symptomatic fractures were observed at adjacent levels. In two of these cases, there was cement leakage into the disc hole. Patients who did not suffer pain refused further surgery.

Kyphoplasty, recently the most modern treatment for OVCF cases, is the most important minimally invasive surgery due to its low complication rates and effectiveness at relieving pain. An effective product has not yet been developed that could be an alternative to PMMA in kyphoplasty applications. The volume of cement to be applied, in order to ease pain and correct kyphosis, which are the most important aims in the treatment of OVCF, should be kept at a maximum of 3 cc in thoracic regions and 5 cc in lumbar regions, in order to reduce complication rates and provide the necessary effective treatment. Additionally, a unilateral cement injection is sufficient for pain removal while providing a reduction in complication rates.

REFERENCES:

1. Amar AP, Larsen DW, Esnaashari N. Percutaneous transpedicular polymethylmethacrylate vertebroplasty for the treatment of spinal compression fractures. *Neurosurgery* 2001; 49: 1105-1114.
2. Blattert TR, Jestaedt L, Weckbach A. Suitability of a calcium phosphate cement in osteoporotic vertebral body fracture augmentation a controlled, randomized, clinical trial of balloon kyphoplasty comparing calcium. *Spine* 2009; 34(2): 108-114.
3. Chen L, Yang H, Tang T. Unilateral versus bilateral balloon kyphoplasty for multilevel osteoporotic vertebral compression fractures. *Spine* 2011; 36(7): 534-540.
4. Dalbayrak S, Onen MR, Yılmaz M, Naderi S. Clinical and radiographic results of balloon kyphoplasty for treatment of vertebral body metastases and multiple myelomas. *J Clin Neuroscience* 2010; 246: 219-224.
5. Eck JC, Nachtigall D, Humphreys SC, Hodges SD. Comparison of vertebroplasty and balloon kyphoplasty for treatment of vertebral compression fractures: a meta-analysis of the literature. *Spine J* 2007; 29: 340-351.
6. Frankel BM, Monroe T, Wang C. Percutaneous vertebral augmentation an elevation in adjacent level fracture risk in kyphoplasty as compared with vertebroplasty. *Spine J* 2007; 7: 575-582.
7. Gaitanis IN, Carandang G, Phillips FM, Magovern B, Ghanayem AJ, Voronov LI, Havey RM, Zindrick MR, Hadjipavlou AG, Patwardhan AG. Restoring geometric and loading alignment of the thoracic spine with a vertebral compression fracture: effects of balloon (bone tamp) inflation and spinal extension. *Spine J* 2005; 5: 45-54.

8. Gaitanis IN, Hadjipavlou AG, Katonis PG, Tzermiadianos MN, Pasku DS, Patwardhan AG. Balloon kyphoplasty for the treatment of pathological vertebral compressive fractures. Eur *Spine J* 2005; 14: 250-260.

9. Garfin SR, Yuan HA, Reiley MA. New technologies in spine: kyphoplasty and vertebroplasty for the treatment of painful osteoporotic compression fractures. *Spine* 2001; 26: 1511-1515. Gill JB, Kuper M, Chin PC, Zhang Y, Schutt R Jr.

10. Comparing pain reduction following kyphoplasty and vertebroplasty for osteoporotic vertebral compression fractures. *Pain Physician* 2007; 10(4): 583-590.

11. Grados F, Depriester C, Cayrolle G. Long term observations of vertebral osteoporotic fractures treated by percutaneous vertebroplasty. *Rheumatology* 2000; 39: 1410-1414.

12. Greendale GA, Barret-Connor E, Ingles S, Haile R. Late physical and functional effects of osteoporotic fractures in women: The Rancho Bernardo Study. *J Am Geriatr* 1995; 43: 955-961.

13. Hulme PA, Krebs J, Ferguson SJ, Berlemann U. Vertebroplasty and kyphoplasty: a systematic review of 69 clinical studies. *Spine* 2006; 31: 1983-2001.

14. Kado DM, Browner WS, Palermo L, Nevitt MC, Genant HK, Cummings SR. Vertebral fractures and mortality in older women: a prospective study, Study of osteoporotic fractures research group. *Arch Intern Med* 1999; 159: 1215-1220.

15. Ledlie J, Renfro M. Balloon kyphoplasty: one- year outcomes in vertebral body height restoration, chronic pain, and activity levels. *J Neurosurg* 2003; 98: 36-42.

16. Lieberman IH, Dudeney S, Reinhardt MK, Bell G. Initial outcome and efficacy of "kyphoplasty" in the treatment of painful osteoporotic vertebral compression fractures. *Spine* 2001; 26: 1631-1638.

17. Liebschner MAK, Rosenberg WS, Keaveny TM. Effect pf bone cement volume and distribution on vertebral stiffness after vertebroplasty. *Spine* 2001; 26: 1547-1554.

18. Lin EP, Ekholm S, Hiwatashi A. Vertebroplasty: cement leakage into the disc increased the risk of new fracture of adjacent vertebral body. *AJNR* 2004; 25: 175-180.

19. Lin WC, Lee YC, Lee CH, Kuo YL, Cheng YF, Lui CC, Cheng TT. Refractures in 282 cemented vertebrae after percutaneous vertebroplasty: a retrospective analysis. *Eur Spine J* 2008; 10: 564-572.

20. Majd ME, Farley S, Holt RT. Preliminary outcomes and efficacy of the first 360 consecutive kyphoplasties for the treatment of osteoporotic vertebral compression fractures. *Spine J* 2005; 5: 244-255.

21. McGraw JK, Lippert JA, Minkus KD, Rami PM, Davis TM, Budzik RF. Prospective evaluation of pain relief in 100 patients undergoing percutaneous vertebroplasty: results and follow-up. *J Vasc Interv Radiol* 2002; 13: 883-886.

22. Mut M, Naderi S. Risk of refracture and adjacent vertebra fracture after vertebroplasty and kyphoplasty. *World Spine J* 2007; 2: 1-4.

23. National Osteoporosis Foundation. America's Bone Health. The State of Osteoporosis and Low Bone Mass in Our Nation. *Washington DC*: NOF 2002.

24. Nirala AP, Vatsan DK, Husain M. Percutaneous vertebroplasty. An experience 31 procedures. *Neurol India* 2003; 51: 490-492.

25. Papadopoulos EC, Edobor-Osula F, Gardner MJ, Shindle MK, Lane JM. Unipedicular balloon kyphoplasty for the treatment of osteoporotic vertebral compression fractures: early results. *J Spinal Disord Tech* 2008; 21:589–596.

26. Patwardhan AG, Havey R, Carandang G, Simonds J, Voronov Li, Ghanayem AJ, Meade KP, Gavin TM, Paxinos O. Effect of compressive follower preload on the flexion-extension response of the human lumbar spine. *J Orthop Res* 2003; 21:540–546.

27. Peters KR, Guiot BH, Martin PA, Fessler RG. Vertebroplasty for osteoporotic compression fractures: current practice and evolving techniques. *Neurosurgery* 2002; 51: 96-103.

28. Phillips FM, Ho E, Campbell-Hupp M, McNally T, Todd Wetzel F, Gupta P. Early radiographic and clinical results of balloon kyphoplasty for the treatment of osteoporotic vertebral compression fractures. *Spine* 2003: 28: 2260-2265.

29. Pradhan B.B, BaeHW, Kopf MA, Patel VV, Delamarter RB. Kyphoplasty reduction of osteoporotic vertebral compression fractures: Correction of local kyphosis versus overall sagittal alignment. *Spine* 2006; 31; 435-441.

30. Riggs BL, Melton LJ. The world wide problem of osteoporosis: insights afforded by epidemiology. *Bone* 1995; 17; 505-511.

31. Salomon C, Chopin D, Benoist M. Spinal cord compression: an exceptional complication of spinal osteoporosis. *Spine* 1988; 13: 222-224.

32. Stanley SK, Ghanayem AJ, Voronov LI, Havey RM, Paxinos O, Carandang G, Zindrick MR, Patwardhan AG. Flexion-extension response of the thoracolumbar spine under compressive follower preload. *Spine* 2004; 29: E510-E514.

33. Taylor RS, Taylor RJ, Fritzell P. Balloon kyphoplasty and vertebroplasty for vertebral compression fractures. A comparative systematic review of efficacy and safety. *Spine* 2006; 31: 2747–2755.

34. U.S. Department of Health and Human Services. Public Health Service. Office 318 of the surgeon general, report of surgeon general's workshop on osteoporosis and bone health. December 12, 2002.

35. Vasconcelos C, Gailloud P, Beauchamp Nj. Is percutaneous vertebroplasty without pretreatment venography safe? Evaluation of 205 consecutives procedures. *AJNR Am J Neuroradiol* 2002; 23: 913-917.

36. Voggenreiter G. Balloon kyphoplasty is effective in deformity correction of osteoporotic vertebral compression fractures. *Spine* 2005; 30: 2806-2812, 2005

37. Wang Z, Wang G, Yang H: Comparison of unilateral versus bilateral balloon kyphoplasty for the treatment of osteoporotic vertebral compression fractures. *J Clin Neuroscience* 2012; 19: 723-726.