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LONG-TERM CLINICAL AND RADIOLOGICAL RESULTS OF VERTEBRAL AUGMENTATION TECHNIQUES IN OSTEOPOROTIC LUMBAR COMPRESSION FRACTURES: VERTEBROPLASTY OR KYPHOPLASTY?

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ABSTRACT

Objective: This study aimed to compare long-term segmental deformity and clinical manifestations associated with vertebroplasty and kyphoplasty in treating single-level vertebral compression fractures.

Materials and Methods: The patients were categorized into four groups based on corpus height loss and surgical procedures: VP1 and KP2 for ≤50% and VP2 and KP1 for >50%. Corpus height losses, restoration rates, segmental kyphotic angle values, visual analogue scale (VAS), and Oswestry disability index (ODI) scores were recorded at the 5-year follow-up.

Results: There was a significant difference in the distribution of cases with corpus height loss ≤50% (VP1 and KP2) and ≥50% (KP1 and VP2) ($p<0.05$). Statistically significant decreases were observed in the restoration rates between the first day and the 60th month of postoperative follow-up for VP1, VP2, and KP1 ($p<0.001$). The restoration rate decreased in KP2 ($p=0.023$). There were no statistically significant changes in the segmental kyphotic angles for VP1, VP2, and KP1 from the first day to the 30th month. The angle of KP2's angle remained unchanged until the 60th month. VAS scores were significantly decreased for VP1, VP2, and KP1 on both the first and sixth day and the sixth (month <0.001). A significant difference was found in ODI values between the pre-operative period and the 5th year for VP1, VP2, and KP1 ($p<0.001$) but not for KP2 ($p=0.003$), indicating better results for KP2.

Conclusion: Vertebroplasty is sufficient in patientscases with a height loss of ≤50%, whereas kyphoplasty is superior in patients with a height loss of >50%.

Keywords: Vertebral augmentation, vertebroplasty, kyphoplasty, osteoporosis, compression fracture

INTRODUCTION

Osteoporosis is a condition that affects the entire skeletal system and is characterized by an increased susceptibility to fractures in multiple areas of the body. This susceptibility is primarily due to the degradation of bone microarchitecture and a reduction in bone mass[1,2]. Vertebral compression fractures (VCF) are the most common complication of osteoporosis, affecting around 50% of individuals aged 50 and above with the condition[3,4]. The annual incidence in the UK is roughly 120,000, while it ranges from 1 to 1.5 million in the US[5,6]. With the aging population and increased life expectancy, the prevalence of osteoporosis and VCF is steadily rising[7,8].

While conservative treatment methods such as pain management and immobilization are initially employed, some cases may benefit from vertebral augmentation (VA) techniques like vertebroplasty (VP), balloon kyphoplasty (KP), and stentoplasty. These procedures aim to improve quality of life by reducing pain and optimizing vertebral alignment, thereby preventing further damage[3,4,9-11].

Existing literature has extensively discussed these procedures' short to medium-term outcomes, benefits, and drawbacks. However, there needs to be more sufficient data on long-term outcomes and changes in treatment preferences. This study aims to offer a new perspective by conducting a comparative analysis of the long-term segmental deformity and clinical manifestations associated with VP and KP, the two commonly used minimally invasive VA techniques for VCF treatment.

MATERIALS AND METHODS

Study Design

This study investigated patients admitted to our hospital's trauma center between 2010 and 2017. All procedures followed were following ethical standards and guidelines, including the Helsinki Declaration of 1975, as revised in 2008. Approval

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was obtained from the University of Health Sciences Turkey, İstanbul Medeniyet University Göztepe Training and Research Ethics Committee (date: 21.06.2023, number: 2023/0402). The study involved a retrospective analysis of cases treated at our clinic using the KP or VP techniques for single-level osteoporotic VCFs. The inclusion criteria were patients diagnosed with osteoporotic VCF who had undergone four weeks of conservative treatment with no sufficient clinical improvement, had no spinal cord compression, and had completed radiological imaging and five-year follow-ups. The acceptance criteria for our osteoporotic VCF diagnosis were that the cases' previous bone mineral density (BMD) values were less than -2.5 (T-score <-2.5) and that they had a previous diagnosis of osteoporosis. BMD was not repeated in our cases who were already diagnosed with osteoporosis. In terms of VCF morphology, Osteoporotic Fracture (OF)2 and OF3 cases were included in our study based on the "AO Spine-DGOU OF Classification System"(12). The exclusion criteria included bleeding disorder, surgical site infection, absence of BMD, not having a diagnosis of osteoporosis, allergy to bone cement, failure to complete cement (polymethylmethacrylate) injection for any reason, VCF due to causes other than osteoporosis, treatment with a technique other than VP or KP, being morphologically OF1, OF4, OF5, failure to complete the 5-year follow-up or missing records. One hundred-twenty one cases were included in the study and categorized into four groups based on variations in corpus height loss and surgical procedures. The VP1 and KP2 groups included individuals with corpus height losses ≤50%, while the VP2 and KP1 groups included individuals with corpus height losses >50%. BMD values of the patients or any other demographic factors did not play a decisive role in the selection of surgical technique.

Chart Data and Radiological Features

Demographic information of all cases, including age, gender, localization data, preoperative corpus height losses, postoperative restoration rates, segmental kyphotic angle values, visual analogue scale (VAS) scores, and Oswestry disability index (ODI) scores, were documented. These variables were measured at various time points, including day 1, 6-month intervals, and up to the 60th month. Radiological measurements were performed using standing lateral X-rays covering the entire spine, including the height of the upper vertebral body, lower vertebral body, fractured vertebral body, and the angle of segmental kyphosis. Essential calculations were performed based on these measurements. The estimated vertebral height (EVH) was calculated by adding the upper vertebral body height to the lower vertebral body height and dividing the sum by two. Vertebral corpus height loss (VCHL) was determined by subtracting the fractured vertebral body height from the EVH, dividing the result by the EVH, and multiplying by 100. The restoration rate was calculated using the formula: 100 - (postoperative VCHL divided by preoperative VCHL, multiplied by 100) (Figure 1)(13).

A conventional surgical method was employed in all of the cases included in our study. The bipedincular approach was chosen as the standard strategy in this study. In each case, a volume of 3 cm^3 of cement, specifically polymethylmethacrylate, was administered by injection from both sides. Cases in which the administration of a complete 6 cm^3 volume of cement (polymethylmethacrylate) injection was not feasible for whatever reason were excluded from the research evaluation.

Statistical Analysis

Statistical analysis was performed using the SPSS 15.0 for Windows software. Descriptive statistics were calculated, including numbers and percentages for categorical variables and mean and standard deviation for numeric variables. The Kruskal-Wallis test was used for independent comparisons of numerical variables among more than two groups, as the normal distribution condition was not met in groups. Subgroup analyses were conducted using the Mann-Whitney U test with Bonferroni correction. The Wilcoxon test was used to analyze numerical variables independent groups, as the differences did not meet the normal distribution condition. The chi-squared test was used to analyze ratios in the groups. The significance level was set at $p<0.05$.

RESULTS

Our study was conducted with a total of 121 osteoporotic VCF cases who met our inclusion criteria. VP technique was applied to 64 (52.9%) of our cases, and KP technique was applied to 57 (47.1%) cases. The mean age was 66 years. While 104 (85.95%) of our cases were female, 17 (14.05%) of our cases were male. There was no statistically significant difference in age and gender distributions between the groups.

From a morphological standpoint, no statistically significant difference was observed between the cases of OF2 (n=60) and

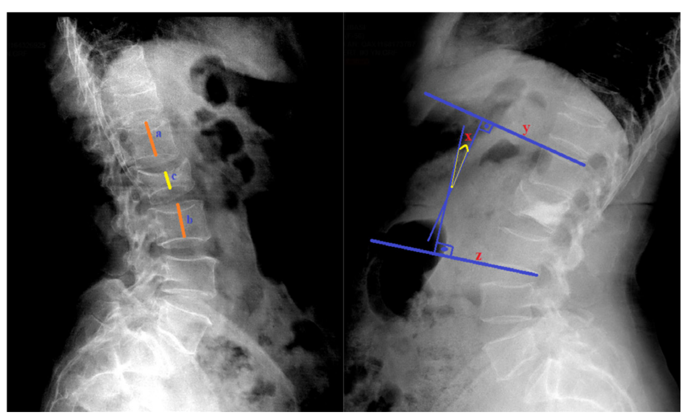

Figure 1. a: Upper vertebral body height, b: Lower vertebral body height, c: Fractured vertebral body height, x: Segmental kyphosis angle, y: Parallel line to the upper end plate of the upper vertebra, z: Parallel line to the lower end plate of the lower vertebra
Estimated vertebral height (EVH): a + b / 2
Vertebral corpus height Loss (VCHL): (EVH - c / EVH) x 100
Restoration rate: 100 – (postop VCHL / preop VCHL x 100)

OF3 (n=61). No statistically significant difference was detected in the prevalence of OF2 and OF3 cases among the various categories. The most common localization of VCF was at TH12 (21.5%), L1 (19.8%), and L3 (17.3%) levels (Table 1).

The distribution of preoperative corpus height losses according to the groups and the statistical differences between the groups are presented in Table 2. There was a significant statistical difference in the distribution of cases with corpus height loss ⩽50% (VP1 and KP2) and ⩾50% (KP1 and VP2) ($p<0.05$).

The statistically significant decreases were observed between the first day and the 60th month of postoperative restoration rates in the VP1, VP2, and KP1 ($p<0.001$). The restoration losses observed in the KP2 did not exhibit statistical significance ($p=0.023$) (Table 3, Figure 2).

The change in segmental kyphotic angles was statistically insignificant in the KP2 group, but statistically significant in the other groups on the first day after the surgery. There was no statistically significant change observed in the segmental kyphotic angles for the VP1, VP2, and KP1 during the postoperative 1st day to 30th month follow-up period. Nevertheless, statistically significant alterations were noted in the follow-up measurements at 36 and 30 months across all three groups. The KP2 showed statistically significant preservation of the observed change from the initial day up to the 60th month (Figure 3).

When comparing the values of segmental kyphotic angle change between the groups, no statistically significant difference was observed between the KP1 and KP2 throughout the follow-up periods. Although there was no statistically significant disparity in the change value of the segmental kyphotic angle between KP1 and VP2 during the preoperative period, a significant difference was observed in favor of KP1 throughout all subsequent months of follow-up. A similar association was similarly noted between the VP1 and VP2. A small level of statistical significance was observed in the comparison between VP1 and KP2, with the results favoring KP2 (Table 4).

A significant statistical difference was observed between the preoperative and 5th-year VAS values for all cases, regardless of the type of surgical procedure performed ($p<0.001$). The study findings indicate a statistically significant decrease in preoperative VAS values for VP1, VP2, and KP1 on both the first day and the sixth month ($p<0.001$). The KP2 showed a statistically significant decrease, although with decreased power on the

Table 1. Distribution of demographic data by groups

		Surgical procedure				
VP 1 n (%) 43 (35.5)		**VP 2 n (%) 21 (17.4)**	**KP 1 n (%) 46 (38.0)**	**KP 2 n (%) 11 (9.1)**		**p (<0.05)**
Age (mean ± SD)		65.9±3.0	64.6±2.8	66.0±3.9	67.7±4.2	0.385
Gender n (%)	Female	40 (93.0)	17 (81.0)	40 (87.0)	7 (63.6)	0.081
	Male	3 (7.0)	4 (19.0)	6 (13.0)	4 (36.4)	
Localization	**L1**	14 (32.6)	4 (19.0)	5 (10.9)	1 (9.1)	
	L2	4 (9.3)	0 (0.0)	5 (10.9)	3 (27.3)	
	L3	1 (2.3)	4 (19.0)	15 (32.6)	1 (9.1)	
	L4	5 (11.6)	0 (0.0)	1 (2.2)	2 (18.2)	
	L5	6 (14.0)	0 (0.0)	0 (0.0)	0 (0.0)	
	T8	4 (9.3)	0 (0.0)	0 (0.0)	0 (0.0)	
	T9	1 (2.3)	1 (4.8)	2 (4.3)	0 (0.0)	
	T10	1 (2.3)	2 (9.5)	1 (2.2)	0 (0.0)	
	T11	0 (0.0)	2 (9.5)	7 (15.2)	3 (27.3)	
	T12	7 (16.3)	8 (38.1)	10 (21.7)	1 (9.1)	

VP1: Vertebroplasty group 1, VP2: Vertebroplasty group 2, KP1: Kyphoplasty group 1, KP2: Kyphoplasty group 2, SD: Standard deviation

Table 2. Distribution of preop corpus height loss by groups and comparison between groups

	VP 1 ⩽50% Mean ± SD	**VP 2 ⩾50% Mean ± SD**	**KP 1 ⩾50% Mean ± SD**	**KP 2 ⩽50% Mean ± SD**
Preop corpus height loss	42.8±3.8	57.2±4.2	58.5±3.8	35.0±4.7
	VP 1 / KP 1 (p)	**KP 2 / KP 1** (p)	**VP 1 / VP 2** (p)	**KP 2 / VP 2** (p)
	<0.001	<0.001	<0.001	<0.001

VP1: Vertebroplasty group 1, VP2: Vertebroplasty group 2, KP1: Kyphoplasty group 1, KP2: Kyphoplasty group 2, SD: Standard deviation

Table 3. Statistical analysis of postop restoration rates of groups according to follow-up times

		VP 1 (p)	VP 2 (p)	KP 1 (p)	KP 2 (p)
Postop. restoration rate (%)	1. day/6. month	**<0.001**	**0.001**	**<0.001**	0.023
	6. month/12. month	1.000	0.083	0.046	1.000
	12. month/18. month	**<0.001**	0.083	0.014	1.000
	18. month/24. month	1.000	1.000	0.046	0.046
	24. month/30. month	1.000	1.000	0.012	0.157
	30. month/36. month	**<0.001**	0.317	0.206	0.102
	36. month/42. month	**0.001**	**<0.001**	**<0.001**	0.020
	42. month/48. month	**0.001**	0.214	0.029	0.102
	48. month/54. month	0.038	0.096	**<0.001**	0.083
	54. month/60. month	0.025	**<0.001**	0.007	0.317
	1. day/60. month	**<0.001**	**<0.001**	**<0.001**	**0.0034**

VP1: Vertebroplasty group 1, VP2: Vertebroplasty group 2, KP1: Kyphoplasty group 1, KP2: Kyphoplasty group 2

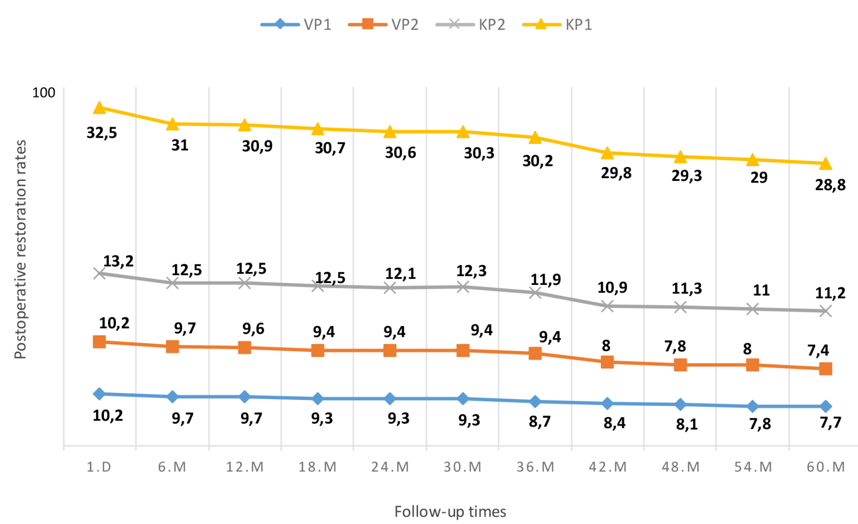

Figure 2. Analysis of postop restoration rates of groups according to follow-up times
VP1: Vertebroplasty group 1, VP2: Vertebroplasty group 2, KP1: Kyphoplasty group 1, KP2: Kyphoplasty group 2, D: Day, M: Month

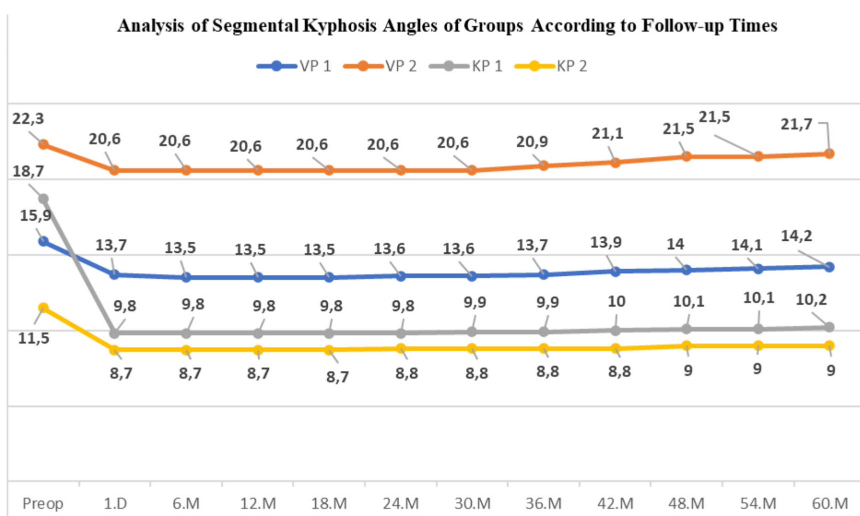

Figure 3. Analysis of segmental kyphosis angles of groups according to follow-up times
VP1: Vertebroplasty group 1, VP2: Vertebroplasty group 2, KP1: Kyphoplasty group 1, KP2: Kyphoplasty group 2, D: Day, M: Month

first day (p=0.003). Although the alterations were noted in the data about subsequent months of observation, they did not exhibit statistical significance. Statistically significant increases in VAS values were observed exclusively in the VP2 following the 36th month (Figure 4). When comparing the VAS values of the groups, there was no statistically significant difference observed between KP1 and KP2, as well as between VP1 and KP2 throughout the duration of the study. Nevertheless, there was no statistically significant difference in preoperative VAS scores between the two groups, KP1 and VP2. However, a significant difference in VAS scores in favor of KP1 was observed during all follow-up months. A similar relationship was noted between the VP1 and VP2 (Table 5).

A statistically significant difference was found between the ODI values, preoperative and the 5th year (p<0.001). While this difference was significant in VP1, VP2 and KP1 (p<0.001), it was significant but relatively lower in KP2 (p=0.003). Preoperative ODI values decreased in KP1 with a statistically significant difference in the first day and the first 12 months (p<0.001). While this decrease for VP1 and VP2 was realized with a high statistical difference on the 1st day (p<0.001), it continued with a statistically lower rate in the first 6 months (for VP1; p=0.001, for VP2; p=0.003). After the 6th month for VP1 and after the 12th month for KP1, the ODI change values showed a statistically stable course. However, a statistically significant increase was observed for VP2 after 36 months (Figure 5). The 1st day data for KP2 was relatively lower than the other groups (p=0.003).

Table 4. Statistical comparison of segmental kyphosis angles of groups according to follow-up periods

		VP1/VP2 (p)	VP1/KP2 (p)	KP1/VP2 (p)	KP1/KP2 (p)
Segmental kyphosis angle	**Preop**	**0.002**	0.062	0.107	**0.005**
	1. day	**<0.001**	**0.004**	**<0.001**	0.401
	6. month	**<0.001**	**0.005**	**<0.001**	0.401
	12. month	**<0.001**	**0.006**	**<0.001**	0.406
	18. month	**<0.001**	**0.006**	**<0.001**	0.401
	24. month	**<0.001**	**0.006**	**<0.001**	0.401
	30. month	**<0.001**	**0.006**	**<0.001**	0.401
	36. month	**<0.001**	**0.006**	**<0.001**	0.407
	42. month	**<0.001**	**0.004**	**<0.001**	0.430
	48. month	**<0.001**	**0.005**	**<0.001**	0.430
	54. month	**<0.001**	**0.004**	**<0.001**	0.418
	60. month	**<0.001**	**0.004**	**<0.001**	0.418

VP1: Vertebroplasty group 1, VP2: Vertebroplasty group 2, KP1: Kyphoplasty group 1, KP2: Kyphoplasty group 2

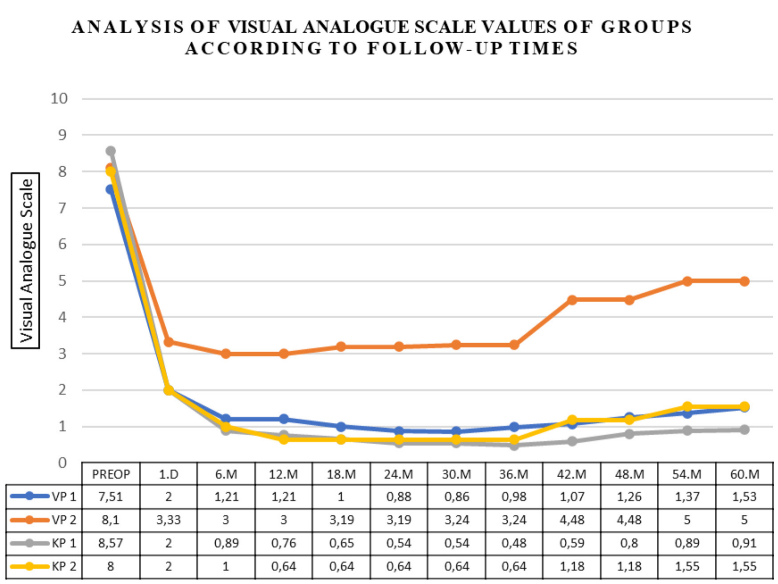

Figure 4. Analysis of visual analogue scale values of groups according to follow-up times
VP1: Vertebroplasty group 1, VP2: Vertebroplasty group 2, KP1: Kyphoplasty group 1, KP2: Kyphoplasty group 2, D: Day, M: Month

This decline continued for the first 6 months and then remained stable (Figure 5).

In the comparison of ODI values between groups; no statistically significant difference was observed between KP1 and KP2 and between VP1 and KP2 during the follow-up periods. However, while there was no significant preoperative ODI difference between KP1 and VP2, a significant difference was observed in favor of KP1 in all follow-up months. Similar relationship was observed between VP1 and VP2 (Table 6).

DISCUSSION

Osteoporosis is a pathological condition affecting the skeletal system, which is defined by a decrease in bone mass, degradation of the microarchitecture of bone tissue, and an elevated vulnerability to fractures[14]. There is a widely accepted consensus that osteoporosis predominantly impacts women. Specifically, women aged 50 years or older exhibit a significantly higher prevalence of osteoporosis, with a fourfold increase compared to males. Additionally, women in this age group also experience a twofold higher incidence of osteopenia in comparison to their male counterparts[15]. Concurrently, our data exhibits a prevalence of female patients. The current scenario aligns with the existing body of literature.

The primary consideration in determining the treatment method for VCF is the assessment of spinal instability, neural compression, and associated neurological symptoms. Decompression and stabilization surgeries are recommended in cases of instability and neurological deficits[4]. However, if patients experience pain without neurological impairment, a trial of conservative treatment with VA techniques may be considered after 4-6 weeks of follow-up[3,4]. VA techniques should also be prioritized in cases where prolonged analgesic therapy and immobilization may lead to vertebral demineralization or when adequate immobilization cannot be achieved due to respiratory and cardiogenic risks[9,10].

Table 5. Statistical comparison of visual analogue scale values between groups according to follow-up periods

		VP1/VP2 (p)	VP1/KP2 (p)	KP1/VP2 (p)	KP1/KP2 (p)
Visual analogue scale	**Preop**	0.008	0.078	0.027	0.032
	1. day	**<0.001**	1.000	**<0.001**	1.000
	6. month	**<0.001**	0.614	**<0.001**	0.703
	12. month	**<0.001**	0.099	**<0.001**	0.542
	18. month	**<0.001**	0.314	**<0.001**	0.963
	24. month	**<0.001**	0.314	**<0.001**	0.501
	30. month	**<0.001**	0.314	**<0.001**	0.501
	36. month	**<0.001**	0.279	**<0.001**	0.350
	42. month	**<0.001**	0.944	**<0.001**	0.162
	48. month	**<0.001**	0.532	**<0.001**	0.477
	54. month	**<0.001**	0.646	**<0.001**	0.091
	60. month	**<0.001**	0.964	**<0.001**	0.091

VP1: Vertebroplasty group 1, VP2: Vertebroplasty group 2, KP1: Kyphoplasty group 1, KP2: Kyphoplasty group 2

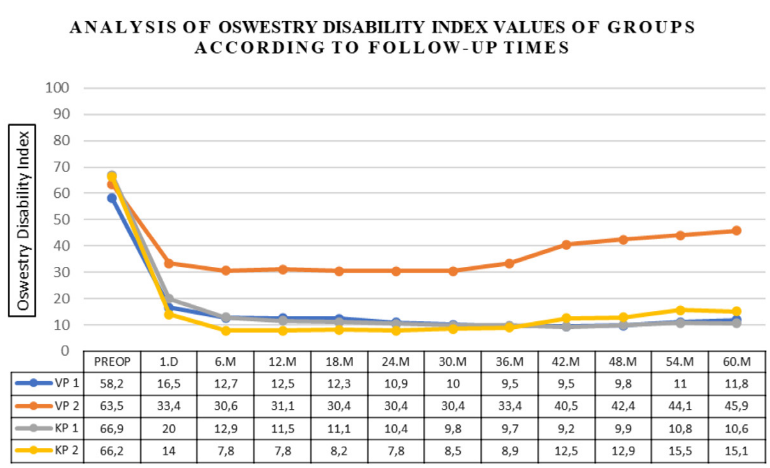

Figure 5. Analysis of Oswestry disability index values of groups according to follow-up times
VP1: Vertebroplasty group 1, VP2: Vertebroplasty group 2, KP1: Kyphoplasty group 1, KP2: Kyphoplasty group 2, D: Day, M: Month

Table 6. Statistical comparison of Oswestry disability index values between groups according to follow-up periods

		VP1/VP2 (p)	VP1/KP2 (p)	KP1/VP2 (p)	KP1/KP2 (p)
Oswestry disability index	Preop	0.035	0.037	0.169	0.469
	1. day	**<0.001**	0.454	**<0.001**	**<0.001**
	6. month	**<0.001**	0.228	**<0.001**	0.009
	12. month	**<0.001**	0.496	**<0.001**	0.074
	18. month	**<0.001**	0.496	**<0.001**	0.095
	24. month	**<0.001**	0.393	**<0.001**	0.087
	30. month	**<0.001**	0.770	**<0.001**	0.200
	36. month	**<0.001**	0.737	**<0.001**	0.174
	42. month	**<0.001**	0.222	**<0.001**	0.250
	48. month	**<0.001**	0.204	**<0.001**	0.420
	54. month	**<0.001**	0.382	**<0.001**	0.203
	60. month	**<0.001**	0.418	**<0.001**	0.132

VP1: Vertebroplasty group 1, VP2: Vertebroplasty group 2, KP1: Kyphoplasty group 1, KP2: Kyphoplasty group 2

Galibert et al.[16] introduced VP, the first VA technique, in 1987 to treat painful vertebral hemangioblastoma. Since then, VP has been used a lot to treat osteoporotic VCFs caused by things like trauma, primary vertebral tumors, multiple myeloma, metastatic vertebral involvement, and angiomas[5,6]. Numerous studies have established the efficacy of VP in managing pain and improving functional quality of life[3,4,17]. However, VP alone is insufficient for restoring vertebral alignment, especially in cases with significant loss of vertebral body height[3,4].

The KP technique was developed in 1998 to address this limitation[18]. Studies comparing different VA techniques have consistently reported positive outcomes[11,19-22]. KP has shown a relative superiority in restoration rates and gain in segment kyphotic angle during the early and mid-term follow-up periods. However, there has yet to be a consensus on the long-term outcomes of different VA techniques, possibly due to variations in technique preference[11,19,20,23,24].

Our study examined the restoration rates of VP and KP groups and segmental kyphotic angle changes. We observed a statistically significant decline in restoration during the initial postoperative period in all groups. This aligns with previous research findings[25]. Bo et al.[26] demonstrated the efficacy of addressing vertebral sagittal alignment disorders in addressing persistent pain following VP. Lin et al.[27] demonstrated a correlation between sagittal imbalance and the potential occurrence of new VCFs in individuals with osteoporosis. Accordingly, one of the primary goals of VA techniques is to restore lost vertebral alignment[3,4,28]. The general opinion is that KP is more effective than VP in restoring lost vertebral alignment[4,11,20,23]. However, long-term studies have reported mixed results, with some showing no significant difference between the two techniques[19].

Our study found a statistically weak change in segmental kyphotic angles in the KP group compared to a statistically significant increase in the VP groups at postoperative day 1. This pattern continued during the initial and middle follow-up periods (up to 30 months) for all groups except KP2. From the 30th month onwards, a statistically significant change was observed in all groups except KP2. We also observed variations in data expression based on follow-up periods, in line with the literature.

Furthermore, during the comparative analysis of the groups, there was a notable disparity in favor of KP1 in cases with a height loss of 50% or more. KP should be preferred in cases with ≥50% height loss. In cases with ≤50% height loss, although our study showed a statistically significant correlation favoring KP2 when considering the percentage of change in data, there was no significant difference with VP. Therefore, we cannot declare significant superiority for either technique in cases with ≤50% height loss.

The mechanisms underlying the analgesic effects of VA techniques are still debated[4]. The mechanical power of segmental corpus reconstruction, stabilization, and the impact of cement hardening on endplates are proposed hypotheses[4,29]. Empirical investigations have shown positive outcomes regarding analgesic properties and functional quality of life improvements for both VP and KP[3,4,11,17,19,21,22].

Many studies have compared VP and KP and found no significant difference in pain control and functional quality of life, especially in the early and mid-term results[11,17,19-22,24,30]. However, some studies have reported a superior functional outcome with KP[31-33]. Our study also showed no significant difference in pain control and functional quality of life between the VP and KP groups, except for the VP2 group after 36 months. These findings align with the existing literature.

In terms of indications, VP is generally recommended for cases with minimal deformity, while KP is preferred for cases with ≥30-40% loss of anatomical morphology[34-40]. However, there is no absolute standardization in these recommendations.

Our study analyzed and interpreted the long-term results of both techniques without preconception. We found that KP was significantly more effective than VP in cases with >50% height loss, based on improvement rates in segmental kyphotic angle changes and functional quality of life. However, in cases with ≤50% height loss, both radiological and clinical data showed similar outcomes for both techniques. Considering the cost difference between the two techniques, VP may be an adequate and effective choice in this group of cases.

Study Limitations

This study had several limitations. First, it was a retrospective study without a control group and no comparison was made with conservative treatments and other treatment methods. Secondly, only cases diagnosed with osteoporotic vertebral compression fracture were included in our study, but other pathologies for which VA techniques are indicated, especially trauma, were not included in our study. Thirdly, the acceptance criteria for our osteoporotic VCF diagnosis were that the cases' previous BMD values were less than -2.5 (T-score <-2.5) and that they had a previous diagnosis of osteoporosis. Therefore, BMD was not repeated in our cases who were already diagnosed with osteoporosis. Fourthly, among the VA techniques, only data on VP and KP techniques were compared; as a handicap, our study does not include new generation VA methods such as stentoplasty. Finally, although our study makes recommendations based on the radiological and clinical results of the cases, it does not include data on the complications of the compared techniques. It is obvious that there is a need for prospective studies in different indications, including new techniques and differences in complications between techniques.

CONCLUSION

The effectiveness and benefits of KP and VP techniques differ depending on the length of the follow-up period. It is essential to consider the specific indications for each technique when choosing the most appropriate option. In cases where the height loss is ≤50%, VP may be sufficient, as there is no significant difference in superiority between the two techniques. However, in cases where there is a height loss greater than 50%, a comparison of the improvement rates in segmental kyphotic angle alterations and sagittal alignment with their impact on long-term functional quality of life revealed that KP was much more effective than VP. Therefore, KP may offer more significant advantages for cases with a height loss of >50%.

Ethics

Ethics Committee Approval: Approval was obtained from the University of Health Sciences Turkey, İstanbul Medeniyet University Göztepe Training and Research Ethics Committee (date: 21.06.2023, number: 2023/0402).

Informed Consent: Informed consent was obtained from patients.

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Authorship Contributions

Surgical and Medical Practices: A.Y.Y., M.V.A., Concept: A.Y.Y., M.V.A., Design: A.Y.Y., M.V.A., Data Collection or Processing: A.Y.Y., M.V.A., Analysis or Interpretation: A.Y.Y., M.V.A., Literature Search: A.Y.Y., M.V.A., Writing: A.Y.Y., M.V.A.

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