



Comparison of Kyphoplasty and Vertebroplasty to increasing the height of vertebral body in Osteoporotic VBF

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General Note



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ABSTRACT

Introduction & Objective: Vertebroplasty and kyphoplasty are low invasive procedures to strengthen the osteoporotic vertebrae. The aim of the present study was to compare the rate of increasing the postoperative vertebral height with kyphoplasty and

vertebroplasty in patients with VBF referred to hospital. *Material Methods:* This descriptive cross-sectional study was performed on patients with acute osteoporotic vertebral body fractures. Patients who underwent vertebroplasty and kyphoplasty were divided into two groups of 28 and met the inclusion criteria. Then, vertebral height, Oswestry Disability Index (ODI) and Visual Analog Scale for Pain (VAS) were measured before surgery, one week and one month after surgery. Finally, relative height was obtained and then compared using height ratios. *Results:* The mean age of the patients was 75.5 ± 9.07 . The mean age of patients in kyphoplasty and vertebroplasty groups were calculated as 74.4 ± 10.25 and 76.6 ± 7.74 years, respectively. In the current study, 80% of the patients were female and the sexual distribution of patients was quite similar in the two surgical methods. In both methods, 80% of the patients were female and the remaining 20% were male. A significant difference in VAS and ODI scores was found between the two groups of kyphoplasty and vertebroplasty, one week and one month after surgery ($p < 0.001$). L1 had the highest frequency of vertebral fractures (40%), while the least fractures belonged to L5 and T11 (3.3%). Mean anterior, middle and posterior height of fractured vertebrae were found to be significantly different in two groups after surgery ($p < 0.001$). Similarly, the mean ratios of anterior, middle, and posterior height of the fractured vertebra were significantly different in the two surgical groups compared to the normal postoperative vertebral height ($p < 0.001$). *Conclusion:* The results of this study showed that both methods are effective in improving the rate of disability and reducing the severity of pain, but the efficacy of kyphoplasty is greater.

Keywords: Kyphoplasty, Vertebroplasty, Osteoporotic fracture, Increased vertebral height.

1. INTRODUCTION

Osteoporosis is one of the most common metabolic bone diseases among the elderly. This disease causes a person to be at risk for bone fractures due to a decrease in bone density (Zhang et al., 2012). During menopause, when estrogen decreases in women, the disease becomes more common (Vacarro et al., 2005). Deficiency of minerals such as calcium, protein, vitamins and the use of tobacco products such as cigarettes can be associated with osteoporosis. In the absence of minerals in the diet, the body compensates for this loss by using bone tissue minerals that causes osteoporosis over time (Abolhassani et al., 2006). Some diseases such as hyperthyroidism, gynecological deficiency, rheumatoid arthritis, cushioning, diabetes and taking certain medications such as corticosteroids, levothyroxine, furosemide, heparin, and phenytoin can also cause osteoporosis over time by aging. Other factors, such as inactivity or an over 10% weight loss comparing the weight of youth or body mass index (BMI) of less than 2, hereditary factors and alcoholism are linked to osteoporosis (Boonen et al., 2011 and Hashidate et al., 2006). Osteoporosis is diagnosed following an acute clinical fracture or a bone mineral density test (Wang et al., 2008). Pain from osteoporotic vertebral fractures often responds to medication but requires more vertebroplasty and kyphoplasty in more severe cases (Anselmetti et al., 2007). Vertebroplasty and kyphoplasty are minimally invasive procedures to strengthen the osteoporosis that can be performed using a fluoroscopy (Live Imaging), (Galibert et al., 1987). Vertebroplasty is a non-invasive treatment for vertebral and spinal hemangiomas. It is also used today in osteoporosis, malignant spine metastasis, traumatic vertebral fractures and rarely in cancers (Arpino et al., 2012).

Vertebroplasty enhances the patient's functional abilities and allows the patient to resume their previous activities, as well as preventing vertebral collapse (Chew et al., 2011). kyphoplasty is considered as an advanced, less invasive technique with more advantages than vertebroplasty such as lower risks of cement, and extrusion, as well as better spine repair and spinal biomechanics (Machinis et al., 2006). In vertebroplasty, the cement is injected into the fracture site, but in kyphoplasty, a special balloon is first inserted into the vertebral chamber and filled with contrast material (at specified pressure) to restore the vertebral wall to its normal position and to maintain vertebral height. The balloon is then removed and the orthopedic cement is injected into the cavity to prevent vertebral collapse. With this treatment, the pain caused by fracture can be dramatically reduced (Fan et al., 2016).

Vertebroplasty and kyphoplasty increase the patient's motor ability due to the reduction of pain, thus the patient can perform his or her daily activities without pain; this treatment also avoids the decrease in height or more vertebral fractures. By increasing movement ability, the rate of osteoporosis can be decreased, that even may be associated with a decrease in risk of lung infections and heart problems. When the vertebral fracture is occurred, like the collapse of a room, vertebral height decreases and causes pain in the lumbar or dorsal vertebrae (Dodangeh et al., 2016). When the vertebra is broken, such as the collapse of a room, vertebral height decreases and causes pain in the lumbar or dorsal vertebrae (Dodangeh et al., 2016). Both kyphoplasty and vertebroplasty are effective in increasing vertebral height and reducing pain. The aim of this study was to compare these two surgical methods in order to introduce the most effective method in reducing pain.

2. MATERIALS AND METHODS

This descriptive cross-sectional study was performed on 56 patients with acute osteoporotic fracture referred to Mehrad and Bu Ali Hospitals in Tehran from 2017 to 2018. A simple random sampling was considered in the present study, for which numbers are selected at random. All patients had normal neurologic status without signs of active infection. Inclusion criteria included informed consent for participation in the study, patients suffering from osteoporotic vertebral fractures for at least the past three months, patients verified as osteoporotic vertebral fractures by X-ray or CT scan or densitometry, and patients with indication and candidate for Vertebroplasty and kyphoplasty.

Exclusion criteria included failure to participate in the study, traumatic vertebral fractures, vertebral fractures for any reason other than osteoporosis, patients with other forms of spinal deformity including stenosis, arthritis, hernia and spinal cord compression, malignancy; primary or metastatic tumor, infectious diseases, drug-induced osteoporosis or internal diseases, and pathological spinal fractures.

Procedure for kyphoplasty

The patient underwent general anesthesia. An empty needle was passed through the pedicle to vertebral body, after inflation and deflation of balloon a mixture of cement was subsequently injected. Calming drugs were given intravenously to the patient. At the end of the procedure, a CT scan is performed to check the position and proper distribution of the cement. The longest part of the kyphoplasty is the needle placement in the best place for the collapsed vertebra.

Procedure for vertebroplasty

An empty needle passed through the vertebrae and a mixture of cement was then injected. Calming drugs will be injected intravenously. The patient may also receive a foley catheter. Through a small incision with a fluoroscopy, an empty needle was passed through the muscles until the tip of the needle reached exactly the fracture site. The surgeon then performed an experiment called intraosseous venography. After making sure that the needle is in the right place of fracture, CT scan was performed to check the position and proper distribution of the cement.

Data collection tools

Patient information was collected through a questionnaire designed by the researcher in the department. Also, three indices of Oswestry Disability Index (ODI) and Visual Analog Scale for Pain (VAS), and bone spine height measurement were used in this study according to the following protocol:

Oswestry Disability Index was used to assess the effect of low back pain intensity on 10 daily activities of pain (pain, self-care ability, lifting, studying, driving, and recreation). The ability to perform any activity on this tool was assessed at 6 levels from "highest performance level" (score) to "lowest performance level" (score 5) with a total score range of zero to 50. Higher scores were considered as more disabilities in the samples. Finally, the score was calculated based on the percentages of minimal disability (less than 20%), moderate disability (20-40%), severe disability (40-60%), crippling back pain (60-80%) and bed-bound (80-100%).

Visual scale of pain severity is a 10cm ruler with the word painless on the left end and the most severe pain on the right end. The Visual Analog Scale for Pain is classified as 0 to 10 as follows: 1-0: no pain, 2-3: low pain, 4-5: high pain, 7-6: very bad pain, 9 -8: maximum pain and 10: unbearable pain.

Furthermore, a simple x-ray was performed on the anterior posterior view of the patients. Then, three anterior (H1), middle (H2) and posterior (H3) heights of the fractured vertebra and the upper healthy vertebra (H *) were also measured by a standard and precise millimeter-based ruler. Finally, the ratio of anterior, middle and posterior height of the fractured vertebrae was measured in comparison with pre and postoperative condition and normal vertebrae.

The patients were divided into two groups of vertebroplasty and kyphoplasty considering the inclusion and exclusion criteria. After sampling, demographic information including age and gender of patients was obtained and included in the designed checklist. VAS and ODI were measured three times before surgery, one week and one month after surgery. Finally, relative height was calculated and compared using height ratios.

Data analysis

The data obtained from questionnaires were entered in SPSS software version 18. Mean and standard deviation were reported for quantitative variables, and absolute and relative frequency for qualitative variables. T-test was used to compare the two types of surgery if the variables were normal. A non-normal distribution leads to use the Wilcoxon test. Friedman test was used to compare

the reduction of pain and disability for data with non-normal distribution and the repeated measures design was applied for normally distributed data. The confidence level was 95% and the significance level was considered to be 0.05.

Ethical considerations

The protocol of this study has been evaluated and approved by the Ethics Committee of Islamic Azad University of Tehran with code IR.IAU.TMU.REC.1396.162. All participants entered the study after a thorough explanation of the research process and signed a written consent. The rules of the study were also based on the Helsinki guidelines. Patients were also assured that the information contained in the patients' records would be confidential and that the information would be published in a group, without publishing their names and personal details.

3. RESULTS

The mean age of the patients was 75.5 ± 9.07 . Mann-Whitney U test results for mean age of patients in kyphoplasty and vertebroplasty groups were determined as 74.4 ± 10.25 and 76.6 ± 7.74 years, respectively. These findings demonstrated that the mean age of the patients was not significantly different between the two groups ($p = 0.287$).

In the present study, 80% of the patients were female and the sexual distribution of patients was quite similar in the two surgical methods. In both methods, 80% of the patients were female and the remaining 20% were male. Thus, the two groups were comparable in terms of sex distribution (Table 1).

Table 1 Comparison of the frequency and percentage of sex in two surgical methods

surgical methods		frequency	percent
kyphoplasty	female	24	80
	male	6	20
vertebroplasty	female	24	80
	Male	6	20

Table 2 shows the frequency of fractures in all patients. L1 vertebral fractures had the highest frequency (40%) and the least fractures belonged to L5 and T11 (3.3%). The results for the two surgical groups are also shown in Table 3.

Table 2 Frequency of vertebral fractures in all patients

Variable	frequency	percent
L1	24	40
L2	13	21/7
L3	4	6/7
L4	5	8/3
L5	2	3/3
T11	2	3/3
T12	10	16/7
total	60	100

Table 3 Frequency of vertebral fractures by surgical method

percent	Frequency	surgical method		percent	frequency	surgical method	
46/7	14	L1	vertebroplasty	33/3	10	L1	kyphoplasty
30/0	9	L2		13/3	4	L2	
3/3	1	L3		10/0	3	L3	
3/3	1	L4		13/3	4	L4	
3/3	1	L5		3/3	1	L5	
3/3	1	T11		3/3	1	T11	
10/0	3	T12		23/3	7	T12	
100/0	30	Total		100/0	30	Total	

The results of Mann-Whitney test showed that there was no significant difference in mean anterior, middle and posterior height of healthy vertebrae in two groups ($p = 0.160$, $p = 0.445$ and $p = 0.369$).

Furthermore, the mean anterior, middle and posterior height of the fractured vertebrae did not differ significantly between the two groups before surgery ($p = 0.642$, $p = 0.154$ and $p = 0.410$). Similarly, the mean ratios of anterior, middle, and posterior height of the preoperative fractured vertebrae did not differ significantly between the two surgical groups in comparison with the anterior height of the healthy vertebrae ($p = 0.871$, 0.050 , $p = 0.141$).

But the mean of anterior, middle and posterior height of the fractured vertebrae was significantly different between the two groups after surgery ($p < 0.001$). According to the results, the mean increasing the anterior height of the fractured vertebra in the kyphoplasty and vertebroplasty group was 1.8 and 1.2, respectively. The mean increasing the median height of the fractured vertebra was 1.7 in the kyphoplasty group and 1.2 in the vertebroplasty group. Also, the mean increasing the posterior height of the fractured vertebra in the kyphoplasty group was reported as 1.8 and this ratio was 1.3 for the vertebroplasty group. In all three cases, the mean increasing the height of the fractured vertebra was found to be significantly better after kyphoplasty.

Similarly, the mean proportions of increasing the anterior, middle, and posterior height of the fractured vertebra after surgery were significantly different between the two surgical groups ($p < 0.001$). Mean ratios in all three cases were higher in the kyphoplasty group (Table 4).

Table 4 Comparison of mean vertebral size in two surgical methods using Mann-Whitney test

vertebral size	surgical methods	Mean \pm SD	Text Mann-Whitney	p-value
Anterior height of healthy vertebra	kyphoplasty	1/96 \pm 0/472	355/5	0/160
	vertebroplasty	1/83 \pm 0/621		
Mid height of healthy vertebra	kyphoplasty	1/873 \pm 0/461	398/5	0/445
	vertebroplasty	1/763 \pm 0/646		
Posterior height of healthy vertebra	kyphoplasty	1/937 \pm 0/452	389/5	0/369
	vertebroplasty	1/817 \pm 0/611		
Anterior height of fractured vertebra before surgery	kyphoplasty	0/917 \pm 0/456	419	0/642
	vertebroplasty	0/863 \pm 0/382		
Mid height of fractured vertebra before surgery	kyphoplasty	0/710 \pm 0/311	354/5	0/154
	vertebroplasty	0/843 \pm 0/323		
Posterior height of fractured vertebra before surgery	kyphoplasty	0/930 \pm 0/404	394/5	0/410
	vertebroplasty	1/043 \pm 0/390		
Anterior height of fractured vertebrae after surgery	kyphoplasty	1/860 \pm 0/392	116	<0/001
	vertebroplasty	1/263 \pm 0/351		
Mid height of fractured vertebrae after surgery	kyphoplasty	1/773 \pm 0/352	160	<0/001
	vertebroplasty	1/293 \pm 0/401		
posterior height of fractured vertebrae after surgery	kyphoplasty	1/87 \pm 0/405	169	<0/001
	vertebroplasty	1/387 \pm 0/395		
Ratio of anterior height of fractured vertebra to anterior height of healthy vertebra	kyphoplasty	0/476 \pm 0/231	439	0/871
	vertebroplasty	0/481 \pm 0/191		
Ratio of mid height of fractured vertebra to mid	kyphoplasty	0/474 \pm 0/507	317/5	0/050

height of healthy vertebra	vertebroplasty	0/494±0/164		
Ratio of posterior height of fractured vertebra to posterior height of healthy vertebra	kyphoplasty	0/510±0/226	350/5	0/141
	vertebroplasty	0/591±0/203		
Ratio of anterior height of fractured vertebra to anterior height of healthy	kyphoplasty	0/965±0/129	105/5	<0/001
	vertebroplasty	0/715±0/154		
Ratio of mid height of fractured vertebra to mid height of healthy vertebra	kyphoplasty	0/983±0/199	159/5	<0/001
	vertebroplasty	0/745±0/176		
Ratio of posterior height of fractured vertebra to posterior height of	kyphoplasty	0/948±0/246	208/5	<0/001
	vertebroplasty	0/787±0/167		

In all patients (in both groups) the anterior, middle and posterior height of the fractured vertebra had a significant difference compared to the preoperative period ($p < 0.001$, Table 5). The anterior vertebral height has changed after surgery by an average of 0.6, followed by median height (mean: 0.7) and posterior height (mean: 0.6). The results revealed that, in all patients (both groups), the anterior, middle and posterior height of the fractured vertebra had a significant difference ($p < 0.001$). Postoperative anterior vertebral height in the kyphoplasty group changed by an average of 0.9 and in the vertebroplasty group by an average of 0.4. The middle vertebral height in the kyphoplasty group has changed by an average of 1.06 after surgery, while this ratio was 0.4 for vertebroplasty group. Postoperative vertebral height in the kyphoplasty group changed by an average of 0.9 and this ration was determined as 0.3 for vertebroplasty group.

Table 5 Comparison of anterior, middle and posterior height changes of the fractured vertebra before and after surgery by type of surgery using Wilcoxon test

Vertebral height	Comparison of anterior height changes before and after surgery		Comparison of mid-height changes of the fractured vertebra before and after surgery		Comparison of posterior vertebral height changes before and after surgery	
	kyphoplasty	vertebroplasty	kyphoplasty	vertebroplasty	kyphoplasty	vertebroplasty
Surgical method						
mean ± SD	-0/943 ±0/45	-0/400±0/283	-1/063 ±0/345	-0/45±0/344	-0/94 ±0/535	-0/343±0/309
Wilcoxon Test	-4/709	-4/557	-4/789	-4/551	-4/706	-4/304
p-value	<0/001	<0/001	<0/001	<0/001	<0/001	<0/001

VAS and ODI scores were assessed in 3 groups before surgery, one week and one month after surgery. The data are indicated in Tables 6. A significant difference was found in terms of VAS changes in the kyphoplasty group at one week and one month after surgery compared to the vertebroplasty method ($p < 0.05$).

In addition, a significant difference was observed in terms of ODI changes in the kyphoplasty group at one week and one month after surgery when comparing with the vertebroplasty method ($p < 0.05$).

Table 6 Comparison of VAS and ODI in vertebroplasty and kyphoplasty group

Variable	type of surgery	Before surgery	One week after surgery	One month after surgery
Visual pain	vertebroplasty	1/9±6/9	1/7±5/9	1/5±4/4
	kyphoplasty	2/2±7/1	0/8±1/9	0/4±1/6
	P value	0/554	<0/0001	<0/0001

Osterian disability	vertebroplasty	7/3±67/1	6/9±61/6	5/8±41/5
	kyphoplasty	6/8±71/2	5/1±34/3	3/6±30/2
	P value	0/603	<0/0001	<0/0001

There was no significant difference in VAS and ODI scores between two groups of kyphoplasty and vertebroplasty ($p < 0.01$), while a significant difference was observed in one week and one month after surgery ($p < 0.05$). The findings illustrated that both methods are effective in improving the rate of disability (ODI) and pain severity (VAS), thus the efficacy of kyphoplasty was revealed to be higher and significantly different ($p < 0.001$) (chart 1 & 2, figure 1 – 3).

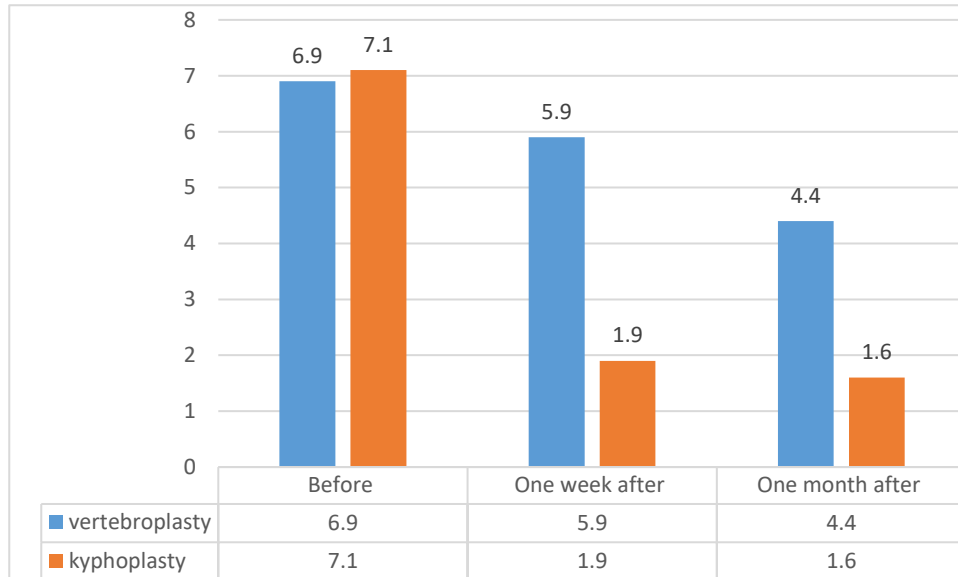


Chart 1 Comparison of Visual pain between vertebroplasty and kyphoplasty

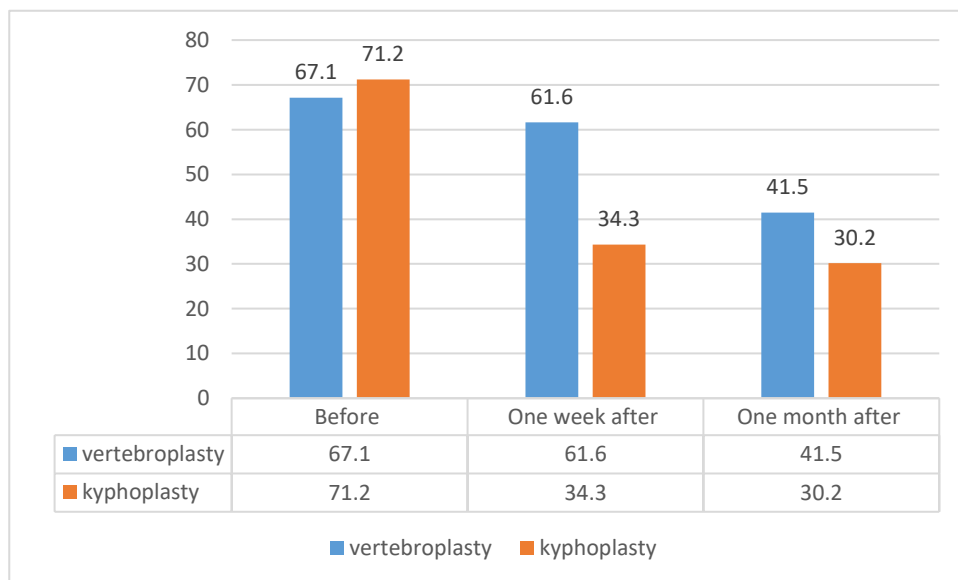


Chart 2 Comparison of Osterian disability between vertebroplasty and kyphoplasty



Figure 1 Axial CT-scan of vertebral body fracture after kyphoplasty

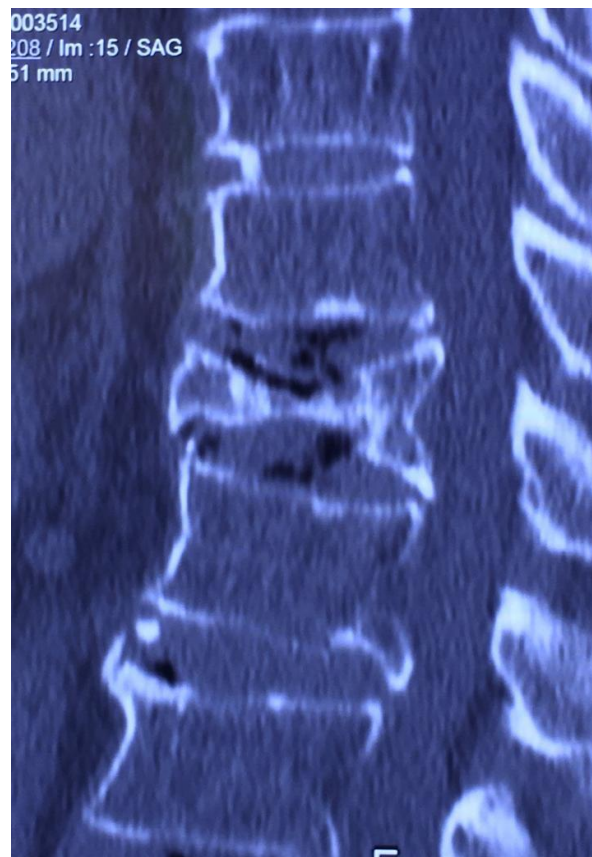


Figure 2 vertebral body fracture CT-scan with Sagittal view

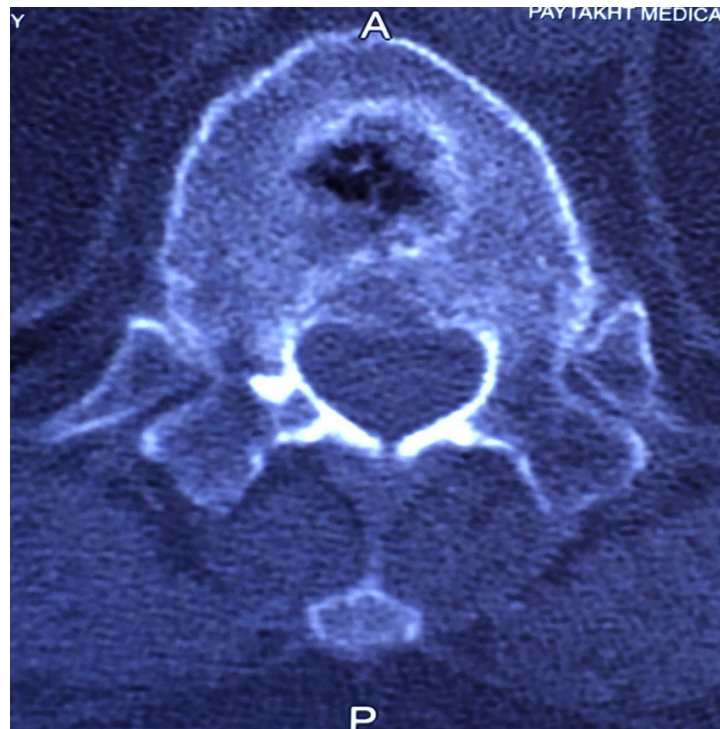


Figure 3 vertebral body fracture CT-scan with axial view

4. DISCUSSION

The present study was conducted in two groups of 30 people and a total of 60 patients were enrolled. Most fractures have been seen in other studies among women, which is consistent with our study. Most studies showed that the average age of fractures was 76 years or older, which is similar to the present study. The results demonstrated that the average age of fracture and prevalent gender were similar in Iran and other countries, despite different lifestyle and nutrition status. Most fractures belong to the L1 vertebra, which is consistent with previous studies.

Fan et al. in 2016 conducted a study on 218 osteoporotic vertebral compression fractures. All patients who underwent vertebroplasty were followed up for 14 months. The VAS scores were reported to be 8.2 ± 1.3 , 1.7 ± 0.9 , and 1.8 ± 0.8 before surgery and 1 week after surgery and at the final follow-up, respectively. The ODI was recorded as $78.2 \pm 13.3\%$, $18.5 \pm 7.3\%$, and $20.9 \pm 6.8\%$ for above mentioned periods. Results of both tests were consistent with the present study. The height of the vertebrae before and one week after surgery and at the end of the study were 19.3 ± 3.2 , 25.1 ± 2.6 and 24.9 ± 2.6 mm, respectively. However, the ratio of changes in the Fan study was higher as compared to the present study (Fan et al., 2016).

Machinis et al. in 2006 performed a study on 24 patients treated with kyphoplasty; they indicated that the mean preoperative VAS score was 9.3 and improved to 5.4 after surgery, which is in agreement with the results of the present study. At 4, 12 and 72 weeks postoperatively, the mean VAS score was determined as 5.1, 5.9, and 6.1, respectively. Pain intensity changes in the present study were greater than in mentioned study (Machinis et al., 2006). Mudano et al. (2019) showed that there is a risk of lumbar spine fractures in both kyphoplasty and vertebroplasty. Among 48 treated patients, 49% were treated with kyphoplasty and 51% with vertebroplasty. The risk of secondary vertebral compression fractures in treated patients was reported to be 6.8 and 2.9, respectively. The present study did not address the possibility of secondary vertebral fractures (Mudano et al., 2009). The present study demonstrated that both methods are generally less aggressive and more effective. The findings of the present study and other studies show that both vertebroplasty and kyphoplasty procedures were capable of increasing the mean postoperative vertebral height in all three conditions, but this increase was significantly found to be better in kyphoplasty. Additionally, pain reduction and ODI were significant in both methods but the efficacy of kyphoplasty was found to be higher than vertebroplasty.

5. CONCLUSION

The results of this study showed that both methods are effective in improving the rate of disability and reducing the severity of pain, but the efficacy of kyphoplasty is greater.

Abbreviations

VBF: vertebral body fracture

ODI: Oswestry Disability Index

VAS: Visual Analog Scale

BMI: body mass index

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Conflicts of Interest: The authors declare no conflict of interest.

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