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Research Article

Percutaneous Vertebroplasty in Traumatic Vertebral Compression Fractures: Analysis of 371 Cases

Oleksandr S Voloshchuk[1]* and Olena P Krasylenko[2]

[1]*NeuroTrauma Department, Romodanov Neurosurgery Institute, Kyiv, Ukraine*

[2]*Department of Miniinvasive and Laser Spinal Neurosurgery, Romodanov Neurosurgery Institute, Kyiv, Ukraine*

***Corresponding Author**: Oleksandr S Voloshchuk, NeuroTrauma Department, The State Institution Romodanov Neurosurgery Institute National Academy of Medical Sciences of Ukraine, Kyiv, Ukraine.

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Abstract

Objectives: The evaluation of short- and long-term results of percutaneous vertebroplasty in patients with isolated traumatic vertebral compression fractures: the dynamics of pain intensity, motor activity and quality of life.

Methods: The short-term and long-term clinical results of percutaneous vertebroplasty (PV) in patients with isolated traumatic vertebral compression fractures (IT VCF) (n = 371) were analyzed, the patients were divided into two groups. Group I - the patients with a high-energy injury to the spine with absent osteoporosis signs (n = 160); Group II - the patients with IT VCF due to minor injury against osteoporosis background (n = 211).

Results: The most significant changes in the rate of back pain, related indicators of motor activity and quality of life (according to Oswestry questionnaire) occur during the first 3 days after PV. Thus, average pain intensity index that characterized the pain as very severe before surgery (8,22 ± 1,39 points in group I and 8,44 ± 1.16 points in group II), after 3 days decreased by 9 and 7,7 times, respectively, to values corresponding to minor pain (0,91 ± 1,01 and 1,1 ± 1,02 points, respectively).

The average motor activity score decreased 5,9 times in group I (from 8,82 ± 1,39 to 1,49 ± 0,76 points); in group II - 5,1 times (from 8,82 ± 1,45 to 1,73 ± 1,01 points). Oswestry Disability Index (ODI), which after the severe trauma corresponded to severe disability in group I (57,7 ± 20,2) and injury - in group II (61,6 ± 17,4), indicated moderate disability in group I 3 days after PV (31,2 ± 16,4) and was on the verge of moderate and severe disability (40,4 ± 14,5) in group II. Further improvement of most of these indicators in the first half-year is progressing gradually.

During the long-term period, the intensity of pain in group I increased insignificantly (from 0,74 ± 0,76 points in 1 year to 0,82 ± 0,89 points after 3 years), in group II it increased statistically significantly ($p < 0,05$) (from 0,91 ± 0,87 points after 1 year to 2,15 ± 1,02 points after 3 years). The average motor activity score in group I increased insignificantly (from 1,11 ± 0,38 to 1,33 ± 0,63), in group II it increased statistically significantly ($p < 0,05$) (from 1,80 ± 1, 01 to 2,59 ± 1,16). ODI in group I remains at 16,7 ± 16,4 (minimal disability), in group II it increases insignificantly within the values corresponding to moderate disability (from 24,6 ± 16,0 to 27,8 ± 17,4).

Conclusion: The rate, completeness and stability of recovery of the functional state are slightly higher in patients of group I. In addition, clinical symptoms, spondylographic and densitometric examination in group I indicate the progression of age-related degenerative changes of the spine, in group II - the prevalence of osteoporotic spondylopathy against these changes.

Keywords: *Traumatic Vertebral Compression Fractures; Percutaneous Vertebroplasty; Pain; Quality of Life; Motor Activity*

Introduction

Spine injury (SI) is one of the most disabling pathologies that presents a significant medical and social problem. Its frequency is constantly high all over the world [1]. In Ukraine, 2 - 3 thousand new cases of SI are reported annually [2,3]. According to Ukrainian authors, about 76% of patients with closed spinal cord injury (SCI) become disabled ones of I-II group [4].

There is still a controversy about the treatment tactics of spine fractures without neurological deficits [5-9]. The range of these treatment approaches is wide: from conservative to aggressive surgical (internal fixation, open transpedicular stabilization, etc.) [10,11]. Percutaneous vertebroplasty (PV) increasingly frequently used worldwide for the treatment of isolated vertebral compression fractures (IVCF) [12-14] is an alternative to conservative therapy and open surgery, a mini-invasive technique that allows to achieve clinical effectiveness of classic surgical treatment while minimizing surgical trauma [15].

Almost 35 years of experience in PV applying indicates that in IVCF of different genesis excellent and good results are achieved immediately after surgery: along with rapid regression of back pain, the quality of life is significantly improved, with the ability to return to normal household loads in a short time [16-18].

Most scientific publications that study the long-term effects of PV in traumatic IVCF indicate that positive results are maintained over the next few years [19,20]. Long-term study of quality of life indicators of patients with isolated IVCF after PV, identification of cases and causes of negative clinical dynamics remains relevant and is the subject of this study.

At the same time, taking into account the economic aspect, some studies indicate the cost-effectiveness of PV compared to non-operated patients [21-23].

Iranian authors register lower cost but not less PV performance compared to balloon kyphoplasty, which is particularly important for low- and below-middle-income countries [24].

Aim of the Research

To evaluate immediate and long-term clinical results of percutaneous vertebroplasty in patients with isolated traumatic vertebral compression fractures on the basis of a comprehensive analysis of the dynamics of pain intensity, motor activity, quality of life.

Materials and Methods

The results of percutaneous vertebroplasty (PV), which was carried out in Department of Miniinvasive and Laser Spinal Neurosurgery, Romodanov Neurosurgery Institute of Ukraine in 2002 - 2016 in patients with isolated traumatic vertebral compression fractures (IT VCF). The operated patients (n = 371, average age - 59,22 ± 0,77 years) were divided into two groups. Group I - patients with high-energy spinal cord injury resulting from a traffic accident or falling from a considerable height, with the absence of osteoporosis signs (n = 160, average age - 50,26 ± 1,24 years); Group II - patients with ITCFVB due to minimal spine injury against osteoporosis (n = 211, average age - 66,01 ± 0,78 years), which is - primary (postmenopausal) in 80,6% (n = 170), secondary (due to corticosteroids, endocrine pathology, etc.) in 19, 4% (n = 41). Severe osteoporosis was diagnosed in 13,3% (n = 28) of patients who had a history of low-energy fractures (5,7% (n = 12) of vertebral body, 7,6% (n = 16) of radial bone).

In short-term postoperative period (3 days, 3 months and 6 months) and in long-term period (1 year, in 3 years, after 3 years), the following characteristics were evaluated:

- Intensity of back pain in scores from 0 (no pain) to 10 (intolerable pain) according visual analog scale (VAS) and other pain

characteristics (nature; conditions under which it occurs/worsens and disappears/diminishes);

- Motor activity in points from 1 (normal activity) to 10 (recumbence with restriction of mobility in bed) according the second block of E.G. Pedachenko's, S.V. Kushchaev's modified scale (2005) [2].

- Quality of life (according to Oswestry questionnaire) in points from 0 (the function studied is not violated) to 5 (the highest degree of its violation) and with calculation of Oswestry index (OI), the values of which from 0 to 20% correspond to the minimum signs of disability; 21 - 40% - moderate disability; 41 - 60% - severe disability; 61 - 80% - injured; 81 - 100% - the state of being bedridden or aggravation [25,26].

The database is created in Excel spreadsheets. Statistical processing was carried out in Statistica 6.0 program using ANOVA statistical method. When comparing two dependent samples (indicators of each of the studied groups at different times after surgery), the non-parametric Wilcoxon test is used. Indicators in many independent samples (in the main group, in group I and in group II in the same terms after surgery) were compared according to Kruskal-Wallis test ($P_{I, II}$).

Results

As shown in table 1, the average intensity of back pain in patients with ITVCF of groups I and II before surgery exceeded 8 points of VAS, which characterized the pain as very severe.

Patients groups		Periods						
		Before surgery	Short-term			Long-term		
			In 3 days	In 3 months	In 6 months	In 1 year	In 3 years	After 3 years
General (n = 371)	(M ± SD)	8,34 ± 1,16	1,02 ± 0,96*	0,84 ± 0,77*	0,82 ± 0,77	0,83 ± 0,17	1,2 ± 0,36*	1,53 ± 1,16*
	Me (LQ;UQ)	8,0 (8.0;9.0)	1.0 (0.0;2.0)	1.0 (0.0;1.0)	1.0 (0.0;1.0)	1.0 (0.0;1.0)	1.0 (0.0;2.0)	2.0 (0.0;3.0)
I (n = 160)	(M ± SD)	8,22 ± 1,39	0,91 ± 0,31*	0,76 ± 0,29	0,71 ± 0,26	0,74 ± 0,26	0,79 ± 0,26	0,82 ± 0,39
	Me (LQ;UQ)	8,0 (7.0;9.0)	1.0 (0.0;1.0)	1.0 (0.0;1.0)	1.0 (0.0;1.0)	1.0 (0.0;1.0)	1.0 (0.0;1.0)	1.0 (0.0;1.0)
II (n = 211)	(M ± SD)	8,44 ± 1,16	1,1 ± 0,12*	0,89 ± 0,11	0,90 ± 0,31	0,91 ± 0,47	1,56 ± 0,22*●	2,15 ± 1,02*●
	Me (LQ;UQ)	8,0 (8.0;9.0)	1.0 (0.0;2.0)	1.0 (0.0;1.0)	1.0 (0.0;1.0)	1.0 (0.0;1.0)	2.0 (1.0;2.0)	3.0 (2.0;3.0)

Table 1: *Intensity of pain in patients with ITVCF before and after PV (points of VAS).*

Notes: M ± SD: Arithmetic averages + standard errors of averages; Me: Median; (LQ;UQ): Interquartile interval;

**: Level of significance of differences in indicators compared to the previous observation period in the same group*

$p < 0,05$; ●: *Level of significance of differences in indicators in groups I and II $p < 0,05$.*

After surgery, the greatest reduction in pain intensity was recorded after 3 days: 9 times in group I; 7,7 times in group II. In the subsequent period, the rate of decrease in pain intensity slowed to 1,2 times after 3 months (in both groups) with further tendencies to decrease (in group I) or increase (in group II).

In long-term postoperative period the intensity of pain in group II gradually increased (after 3 years - by 1,9 times; after 3 years - by 1,6 times), in group I there was only a tendency for its some increase. Analysis of other pain characteristics showed that during this period in group I the pain was probably associated mainly with spondyloarthrosis (occurred at night when turning in bed, at the "start" of morning movements, then eased during physical exercise and walking, further aggravated with carrying heavy items, prolonged upright position), while in group II the pain most often occurred with axial loads and was relieved in lying position, which is typical of osteoporotic spondylopathy. Thus, in the long-term period, the increase in pain intensity in group I was caused mainly by regular age-related degenerative-dystrophic changes of the spine, while in group II it was mainly due to osteoporosis progression. This was confirmed by spondylographic and densitometric data.

Pain syndrome is a major factor limiting motor activity and reducing overall quality of life in patients with ITVCF.

Before surgery, the motor activity index ranged from 5 points (3,1% (n = 5) in group I and 4,3% (n = 9) in group II) to 10 points (45,0% (n = 72)) and 46,4% (n = 98), respectively) and in both groups approached averagely to 9 (Table 2).

Patients groups		Periods						
		Before surgery	Short-term			Long-term		
			In 3 days	In 3 months	In 6 months	In 1 year	In 3 years	After 3 years
General (n = 371)	(M ± SD)	8,82 ± 1,35	1,63 ± 0,77*	1,43 ± 0,77*	1,39 ± 0,77	1,47 ± 0,77	1,67 ± 0,96*	2,0 ± 0,06*
	Me (LQ;UQ)	9.0 (8.0;10.0)	1.0 (1.0;2.0)	1.0 (1.0;2.0)	1.0 (1.0;2.0)	1.0 (1.0;2.0)	1.0 (1.0;2.0)	2.0 (1.0;3.0)
I (n = 160)	(M ± SD)	8,82 ± 1,39	1,49 ± 0,76*●	1,08 ± 0,38*●	1,05 ± 0,2●	1,11 ± 0,3●	1,24 ± 0,6●	1,33 ± 0,6●
	Me (LQ;UQ)	9.0 (8.0;10.0)	1.0 (1.0;2.0)	1.0 (1.0;1.0)	1.0 (1.0;1.0)	1.0 (1.0;1.0)	1.0 (1.0;1.0)	1.0 (1.0;1.0)
II (n = 211)	(M ± SD)	8,82 ± 1,45	1,73 ± 1,01*●	1,70 ± 1,0●	1,65 ± 1,0●	1,80 ± 1,0●	2,05 ± 1,0●	2,59 ± 1,16*●
	Me (LQ;UQ)	9.0 (8.0;10.0)	1.0 (1.0;2.0)	1.0 (1.0;2.0)	1.0 (1.0;2.0)	2.0 (1.0;2.0)	2.0 (1.0;2.0)	2.0 (2.0;3.0)

Table 2: *Motor activity in patients with ITVCF before and after PV (points according to second block of E.G. Pedachenko's, S.V. Kushchaev's modified scale [2]).*

*Notes: M ± SD: Arithmetic averages + standard errors of averages; Me: Median; (LQ;UQ): Interquartile interval; *: Level of significance of differences in indicators compared to the previous observation period in the same group* $p < 0,05$; ●*: Level of significance of differences in indicators in groups I and II* $p < 0,05$.

Three days after surgery, motor activity of patients in group I mainly (60,6% (n = 97)) corresponded to point 1 (normal activity, which occurred before the injury) and did not exceed 4 points (1,9% (n = 3)) (ability to do some homework; length of stay in a vertical position during the day is equal to duration of rest and stay in a horizontal position). In group II, patients with a motor activity score of 1 point (50,3% (n = 106)) also predominated, but in 1,4% (n = 3) of patients it reached 6 points, which indicated the need for additional means (crutches, sticks or walkers) when moving. The average score of motor activity in group I decreased 5,9 times, compared with the preoperative one; in group II - 5,1 times (See table 2).

In the subsequent period of short-time period (up to 6 months) the rates of improvement of motor activity in both groups slowed down (See table 2). At the same time, full recovery in group I was observed in 96,3% (n = 154), in group II - in 54,5% (n = 115), and the maximum degree of decrease in motor capabilities reached, respectively, 3 points 1,2% (n = 2) and 6 points 1,4% (n = 3).

Dynamics of locomotor activity in the long-term postoperative period in both groups generally followed trends in pain intensity (See table 1 and 2) and indicated some impairment of locomotor capacity at the end of observation.

The quality of life assessment of patients according to ODI after trauma was consistent with severe disability (in group I) and injury (in group II) (Table 3).

Groups of patients		Periods						
		Before surgery	Short-term			Long-term		
			In 3 days	In 3 months	In 6 months	In 1 year	In 3 years	After 3 years
General (n = 371)	(M ± SD)	59,9 ± 19,3	36,4 ± 15,4*	22,0 ± 17,3*	20,7 ± 15,4	20,9 ± 15,4	21,7 ± 17,3	22,6 ± 17,3
	Me (LQ;UQ)	64.0 (50.0;74.0)	42.0 (24.0;48.0)	22.0 (6.0;36.0)	20 (6.0;32.0)	20 (6.0;31.0)	20 (6.0;36.0)	22 (6.0;37.0)
I (n = 160)	(M ± SD)	57,7 ± 20,2	31,2 ± 16,4*	18,8 ± 11,7*	18,5 ± 12,7	16,7 ± 10,4	16,5 ± 10,4	16,7 ± 10,4
	Me (LQ;UQ)	60.0 (40.0;74.0)	32.0 (20.0;46.0)	16.0 (0.0;30.0)	16.0 (0.0;30.0)	14.0 (0.0;26.0)	14.0 (2.0;24.0)	12.0 (2.0;26.0)
II (n = 211)	(M ± SD)	61,6 ± 17,4	40,4 ± 14,5*●	24,5 ± 17,4*●	22,5 ± 16,0●	24,6 ± 16,0●	26,2 ± 17,4●	27,8 ± 17,4
	Me (LQ;UQ)	64.0 (50.0;74.0)	44.0 (32.0;50.0)	28.0 (8.0;38.0)	22.0 (8.0;36.0)	28 (9.5;38.0)	27 (13.5;40.0)	29 (16.0;44.0)

Table 3: *ODI in patients* із *ITVCF before and after PV.*

*Notes: M ± SD: Arithmetic averages + standard errors of averages; Me: Median; (LQ;UQ): Interquartile interval; *: Level of significance of differences in indicators compared to the previous observation period in the same group* $p < 0,05$; ●*: Level of significance of differences in indicators in groups I and II* $p < 0,05$.

Three days after PV, quality of life improved significantly and was consistent with moderate disability in group I; in group II it was on the verge of moderate and severe disability.

After 3 months, the level of disability in group I decreased significantly ($p < 0,05$) and remained minimal throughout the next observation in the short-term and long-term periods. In group II, after 3 months, the level of disability also significantly ($p < 0,05$) decreased to moderate and remained same until the end of observation.

At the same time, there were intergroup differences in postoperative ODI dynamics. If group I had a tendency for its continuous decline in the first 3 years after PV, and then a tendency for some of its growth, then group II had a tendency to decrease only during the first half of the year, and its insignificant growth was further observed. As already mentioned, it was at this time that the largest number of

recurrent PVs occurred due to new osteoporotic vertebral fractures, the average duration of which was 10,1 ± 9,8 months after primary PV. That is, the deterioration of quality of life in the long term in patients with low-energy ITVCF on osteoporosis background is due to progression of this pathology.

Discussion

In recent years, the results of many multicenter, randomized, placebo-controlled studies and meta-analyzes have been published that confirm or deny the effectiveness of PV in acute osteoporotic vertebral compression fractures (VCF). In particular, the results of the VERTOS IV and Cochrane study [27,28] with high and moderate levels of evidence prove that in osteoporotic fractures PV do not lead to an additional reduction in pain compared to placebo, but are not a harmful procedure. VAPOR research data [29] and others [21,30,31] on the contrary, prove the effectiveness of PV in this pathology. Such diversity may be due to differences in the criteria for inclusion in the study, especially such as remoteness and fracture subtype, severity of pain before surgery.

Our study illustrates PV efficacy in reducing pain and improving quality of life in patients with acute VCF of A1 type with AO/ASIF [32] both with (n = 211) and without osteoporosis (n = 160).

Prior to PV, a decrease in quality of life in VCF is mainly due to back pain. According to our data, regression of pain syndrome during PV was significant immediately after surgery and during the first days after surgery contributed to the improvement of quality of life, allowing early activation and significantly higher level of motor activity of patients in both study groups. At the same time, the rate and completeness of recovery prevailed in patients without osteoporosis.

In the long term, as expected due to osteoporosis progression and occurrence of new fractures in 14,2% of patients in the respective study group, worsening rates of pain intensity, motor activity and quality of life were observed compared with the early postoperative period, as well as compared with the early postoperative period and also with group of patients without osteoporosis.

Similar worsening rates were observed in the long term in patients with osteoporotic VCF comparing with group of patients without osteoporosis.

The same trend in the long period after PV in patients with osteoporotic VCF was noted [33].

Thus, our study showed the high efficacy of PV in VCF of A1 both in patients without osteoporosis and on the background of osteoporosis, as well as the long-term preservation of positive results in the long term in patients without osteoporosis.

The findings contradict the results of recent studies published [27,28]. In addition, the monocentricity and lack of sham control in our study does not allow us to compare this study with the abovementioned, but our results indicate the importance of a thorough examination of a patient and the choice of the treatment method for VCF considering genesis, subtype and remoteness of the fracture.

Conclusion

Thus, performing percutaneous vertebroplasty in isolated traumatic vertebral compression fractures provides rapid regression of pain and improvement of pain-associated indicators of locomotor activity and quality of life in patients with high-energy spinal trauma in the absence of osteoporosis and in patients with trauma and osteoporosis.

More significant positive changes occur within the first 3 days after surgery. Further improvement of most indicators during the first half-year is progressing gradually. The rates, completeness, and stability of recovery of functional status are slightly higher in patients without osteoporosis.

Conflict of Interest

None declared.

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