The Influence of Preoperative Psychological States on Postoperative Outcomes Following Percutaneous Kyphoplasty(PKP)

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Abstract

Background: Psychological disorder is widespread in patients with spinal conditions. There is limited investigation into the association between preoperative psychological symptoms(PPS) and postoperative outcomes following percutaneous kyphoplasty(PKP) in patients suffered osteoporotic vertebral compression fracture(OVCF) .

Methods: This is a retrospective study performed on 224 patients undergoing PKP due to OVCF. Patients are divided into two cohorts base on preoperative psychological states described by Hamilton Depression Scale(HAMD) and Hamilton Anxiety Scale(HAMA). Pre- and postoperative physical function were evaluated by Patient-Reported Outcome Measurement Information System Physical Function(PROMIS PF), and Visual Analogue Scales(VAS) was used to to evaluate patients' back pain. Multiple linear regression model was used to investigate the association between preoperative psychological symptoms and postoperative outcomes.

Results: 133(59.4%) patients have PPS, manifested as HAMD score ≥ 7 and/or HAMA score ≥ 7 . Patients with PPS have significantly worse PROMIS PF scores preoperatively (26.6 ± 7.6 vs. 34.2 ± 6.9 , $p=0.000$), as well as within 6 months postoperatively, 1-week (31.1 ± 6.5 vs. 37.4 ± 7.2 , $p=0.000$), 1-month (35.3 ± 6.2 vs. 41.1 ± 7.4 , $p=0.023$), 3-months (38.5 ± 8.3 vs. 45.8 ± 8.5 , $p=0.005$), and 6-months (42.8 ± 8.0 vs. 51.2 ± 9.1 , $p=0.000$). Patients with PPS have higher VAS scores preoperatively(8.3 ± 1.6 vs. 6.9 ± 1.9 , $p=0.001$), as well as within 1 month following operation, 1-week (6.2 ± 1.7 vs. 4.1 ± 1.2 , $p=0.000$), 1-month (4.0 ± 1.1 vs. 2.5 ± 1.0 , $p=0.015$).

Conclusion: Psychological symptoms are widespread in OVCF patients undergoing PKP. Patients with poor preoperative psychological states not only demonstrated worse preoperative physical function and back pain, but also continued to have significantly worse postoperative outcomes.

Background

Osteoporotic vertebral compression fracture(OVCF) is considered to be the most common and serious complication in elderly patients with osteoporosis. Approximately 20% of people aged 50 years or older will present with OVCF, and the incidence continues to rise with increasing age. Whats more, in the year after a vertebral compression fracture there is a 20% risk of sustaining a further vertebral compression fracture[1]. OVCF can lead to severe back pain, movement limitation and low back deformity, thus reducing the life quality of patients[2]. Percutaneous kyphoplasty(PKP) has been proved to be an effective method and has been widely used in the treatment of OVCF. Though it is effective in relieving pain and improving postoperative functions in OVCF[2–4], some patients still have residual back pain and dysfunction after PKP surgery[34], and these are main factors affecting patients' life quality and satisfaction with PKP surgery.

Psychological disorders are widespread in fracture patients[35–37]. Symptoms such as depression and anxiety are associated with postoperative outcomes following orthopedic surgery. Few researches

focused on psychological states of patients with spine conditions[14–16], Miller et al[16] proved that the existence of preoperative depression is related to the reduction of postoperative outcome and quality of life after lumbar fusion. Joon et al[13] confirmed that minimally invasive transforaminal lumbar interbody fusion patients with worse preoperative mental health continued to have significantly worse postoperative outcomes within 1 year after surgery. Considering OVCF, patients are more likely to experience psychological disorders during perioperative period due to age, high rate of disability, long fracture recovery time and high risk of recurrence. However, to our best knowledge, no research has reported the psychological disorders of OVCF patients, and whether preoperative psychological factors were associated with postoperative outcomes of PKP procedure also remains unknown.

The present study aim to explore the psychological states of OVCF and demonstrate whether preoperative psychological symptoms(PPS) can predict postoperative outcomes following PKP. Psychological symptoms such as depression and anxiety were assessed by the Hamilton Depression Scale(HAMD) and the Hamilton Anxiety Scale(HAMA). Postoperative outcomes including physical function and back pain were measured by Patient-Reported Outcome Measurement Information System Physical Function(PROMIS PF) and Visual Analogue Scales(VAS).

Materials And Methods

Patients

This was a retrospective study including 224 inpatients with OVCF in our department since January 2017 to September 2019. The inclusion criteria were as follows: 1) acute vertebral compression fracture(within 1 week); 2) age $\geq$ 60 years ; 3) single segmental fracture and fracture level lower than T6; 4) decreased bone mineral density(T scores less than -1.5). Patients combined with other trauma or fractures, with previous other spinal surgery, with metabolic bone diseases, metastasis, uncorrectable coagulopathy, spinal deformity, spinal infection, severe cardiopulmonary and cerebrovascular diseases, or mental disease who could not to complete the questionnaire survey were excluded.

Treatments

All patients were confined to strict bed rest after fracture, nonsteroidal anti-inflammatory drugs were given to all patients, PKP procedures were performed within 1 week after fracture.

Patients were placed in a prone position on the operating table, local infiltration anesthesia and operation was performed by 2 senior orthopedists. Bone puncture trocars were placed through the lateral margin of the pedicles at 10 o'clock on the left side and at 2 o'clock on the right side as entry points at the fractured level and were progressively passed through pedicles into the anterior third of the vertebral body under C-arm guidance. Then, an inflatable bone balloon was used and polymethylmethacrylate was injected carefully into the vertebral body (approximately 3-5 cc per level). The injection was stopped if the cement reached the cortical edge of the vertebral body or if it leaked into extraosseous structures or veins. After the procedure, the patients were maintained in a prone position for 10-15 minutes.

All patients were examined by spinal X-ray 3 days after operation to confirm the distribution of bone cement. Nonsteroidal anti-inflammatory drugs were given to all patients within 1 week following operation and soft lumbar support belts were given to all patients within 1 month postoperatively. All patients resumed functional exercise routinely 1 day after operation and were reexamined regularly in out-patient clinic.

Data Collection

All patients were followed-up for 1 year after operation, the preoperative questionnaire survey was completed in the ward in paper form and postoperative questionnaire survey was at the timepoints of 1 week, 1, 3, 6, and 12 months after surgery. Demographic variables including age, gender, diabetes status, body mass index(BMI), insurance status and times of PKP surgery were assessed. Perioperative outcomes were also recorded, including anesthesia type, duration of operation, blood loss and length of hospital stay.

Preoperative depression and anxiety were each evaluated using HAMD and HAMA[17,18], both these scales are considered to be one of the most standardized and validated tools in psychiatry for research purposes. The HAMD-17 contains 17 items and higher the total score means more severe the depressive symptoms, in this paper, a total score of 7 points and above indicates there is depression. The HAMA consists of 14 items and 2 factors (somatic anxiety and mental anxiety) and the higher the total score also means more severe anxiety symptoms, in this paper, A total score of 7 points and below indicates no anxiety. All patients were divided into two cohorts according to the results of preoperative psychological questionnaire, patients with HAMD score ≥ 7 and/or HAMA score ≥ 7 were considered to have PPS, while HAMD score ≤ 7 and HAMA score ≤ 7 indicates that there are no PPS.

Functional outcomes were measured by Patient-Reported Outcome Measurement Information System Physical Function(PROMIS PF), compared with the traditional measurements, PROMIS PF showed good discriminant ability, concurrent effectiveness and responsiveness. A higher PROMIS PF score indicates better physical function. Visual Analogue Scales (VAS) was used to assess the back pain of patients[19], with a mark on a 10-cm line that best described their present level of pain, higher the VAS score also means more severe back pain.

Statistical Analyses

Continuous variables were presented as means and their standard deviations (SD). All statistical analyses were performed using Statistical Package for Social Sciences (SPSS) version 18.0. The normal distribution of the sample patient population was examined by the histogram, so as to evaluate the symmetry of the sample patient population. Independent sample t-tests were used to determine the difference of demographic variables as well as perioperative outcomes between two cohorts. Multiple linear regression model controlling demographic variables were used to analyze physical function and pain pre- and post PKP in relation to depression and anxiety. Stepwise regression was used to determine independent risk factors for postoperative physical function after PKP including demographic variables

and perioperative outcomes, the variables with the highest p-values were then excluded until only those that were significant remained. Finally, only patients' age and times of PKP surgeries were determined as independent risk factors related to postoperative outcomes following PKP, and be included into the multiple regression analysis. P value ≤ 0.05 was considered statistically significant.

Results

A total of 224 patients were enrolled in this study, including 169(75.4%) patients underwent PKP for the first time, while the other 55(24.6%) patients underwent PKP secondly or more due to recurrent OVCF. Demographic variables and perioperative outcomes of patients and their relations with preoperative mentality are described in Table 1. Perioperative outcomes are described in Table 2. 133(59.4%) patients have PPS, manifested as HAMD score ≥ 7 and/or HAMA score ≥ 7 , while the other 91(40.6%) without PPS. Patients with PPS(75.3 ± 9.3 years) were significantly older than those without(69.5 ± 7.6 years), $p = 0.013$. Patients underwent PKP surgery secondly or more were more likely to have PPS than those for first time, $p = 0.001$. The other demographic variables such as gender, diabetes status, BMI, insurance status and perioperative outcomes including duration of operation, blood loss and length of hospital stay were identified to have no significant differences between the two cohorts($p > 0.05$).

Table 1
Baseline Characteristics

	With PPS (N = 133)	Without PPS (N = 91)	p-value
Age (Mean ± SD)	75.3 ± 9.3	69.5 ± 7.6	0.013*
Times of PKP(n)			0.001**
First time	93(69.9%)	76(83.5%)	
Second or more	40(30.1%)	15(16.5%)	
Gender (n)			0.248
Female	109(82.0%)	78(85.7%)	
Male	24(18.0%)	13(14.3%)	
Diabetes status(n)			0.326
Non-diabetic	120(90.2%)	81(89.0%)	
Diabetic	13(9.8%)	10(11.0%)	
BMI Category (n)			0.517
Non-Obese (< 30 kg/m ²)	62(46.6%)	49(53.8%)	
Obese (≥ 30 kg/m ²)	71(53.4%)	42(46.2%)	
Insurance Status(n)			0.172
Social Insurance	70(52.6%)	45(49.5%)	
Non-Social Insurance	63(47.4%)	46(50.5%)	
Data are presented as number or Mean ± SD. *p ≤ 0.05, **≤0.001. PPS: preoperative psychological symptoms. HAMD score ≥ 7 and/or HAMA score ≥ 7 were considered to have PPS, HAMD score ≤ 7 and HAMA score ≤ 7 indicates no PPS.			

Table 2
Perioperative Outcomes

	With PPS (N = 133)	Without PPS (N = 91)	p-value
Operative Time (Mean $\pm$ SD, min)	50.3 $\pm$ 10.9	52.8 $\pm$ 8.7	0.532
Blood Loss (Mean $\pm$ SD, mL)	11.2 $\pm$ 2.3	9.8 $\pm$ 1.9	0.251
Length of Stay (Mean $\pm$ SD, day)	3.5 $\pm$ 1.2	3.0 $\pm$ 0.9	0.103
Data are presented as number or Mean $\pm$ SD. * $p \leq 0.05$, ** ≤ 0.001 . PPS: preoperative psychological symptoms. HAMD score ≥ 7 and/or HAMA score ≥ 7 were considered to have PPS, HAMD score ≤ 7 and HAMA score ≤ 7 indicates no PPS.			

The effect of PPS on pre- and postoperative outcomes was described in Table 3. Patients with PPS had significantly worse PROMIS scores preoperatively (26.6 $\pm$ 7.6 vs. 34.2 $\pm$ 6.9, $p = 0.000$), as well as within 6 months postoperatively, 1-week (31.1 $\pm$ 6.5 vs. 37.4 $\pm$ 7.2, $p = 0.000$), 1-month (35.3 $\pm$ 6.2 vs. 41.1 $\pm$ 7.4, $p = 0.023$), 3-months (38.5 $\pm$ 8.3 vs. 45.8 $\pm$ 8.5, $p = 0.005$), and 6-months (42.8 $\pm$ 8.0 vs. 51.2 $\pm$ 9.1, $p = 0.000$). No statistical difference of PROMIS PF score was found between two cohorts 12 months postoperatively (Fig. 1). Patients with PPS had significantly higher VAS scores preoperatively (8.3 $\pm$ 1.6 vs. 6.9 $\pm$ 1.9, $p = 0.001$), as well as within 1 month following operation, 1-week (6.2 $\pm$ 1.7 vs. 4.1 $\pm$ 1.2, $p = 0.000$), 1-month (4.0 $\pm$ 1.1 vs. 2.5 $\pm$ 1.0, $p = 0.015$). VAS scores between two cohorts was found no statistical difference from 1 month postoperatively to the end of follow-up (Fig. 2).

Table 3
Postoperative Outcomes

	With PPS (N = 133)	Without PPS (N = 91)	p-value
PROMIS PF(Mean ± SD)			
Preoperative	26.6 ± 7.6	34.2 ± 6.9	0.000**
1-Week	31.1 ± 6.5	37.4 ± 7.2	0.000**
1-Month	35.3 ± 6.2	41.1 ± 7.4	0.023*
3-Month	38.5 ± 8.3	45.8 ± 8.5	0.005*
6-Month	42.8 ± 8.0	51.2 ± 9.1	0.000**
12-Month	50.6 ± 10.8	52.8 ± 11.2	0.121
VAS (Mean ± SD)			
Preoperative	8.3 ± 1.6	6.9 ± 1.9	0.001**
1-Week	6.2 ± 1.7	4.1 ± 1.2	0.000**
1-Month	4.0 ± 1.1	2.5 ± 1.0	0.015*
3-Month	2.6 ± 1.0	2.3 ± 0.8	0.428
6-Month	2.4 ± 0.5	2.3 ± 0.6	0.365
12-Month	2.3 ± 0.7	2.2 ± 0.4	0.121
Data are presented as number or Mean ± SD. *p ≤ 0.05, **≤0.001. PPS: preoperative psychological symptoms. HAMD score ≥ 7 and/or HAMA score ≥ 7 were considered to have PPS, HAMD score ≤ 7 and HAMA score ≤ 7 indicates no PPS.			

Discussion

Symptoms of depression and anxiety are common after skeletal trauma and are strongly related to pain and disability[35–37]. Psychological symptoms are found to be widespread in patients undergoing PKP due to OVCFs, with 133(59.4%) patients having depression and/or anxiety symptoms in this study. This may be related to age, high risk of recurrence, and complications such as severe low back pain and disability caused by OVCFs. Shanbehzadeh et al[19] confirmed in their study that low back pain can cause serious anxiety and depression in patients with spine conditions. Ivo [20] found alterations of grey matter architecture in patients with low back pain and proved that psychological symptoms are associated with low back pain. In this study, psychological symptoms are found to be widespread in patients undergoing PKP due to OVCF, with 133(59.4%) patients having depression and/or anxiety symptoms. This may be related to age, high risk of recurrence, and complications such as severe low back pain and disability caused by OVCF. What's more, we found that older OVCF patients and patients underwent PKP secondly or more are more likely to have preoperative psychological symptoms. The

elderly are more likely to develop a sense of fear when experiencing fracture, and pain memories of previous fracture may aggravate psychological disorder of patients. Studies have shown that the incidence of OVCF continues to rise with increasing age and OVCF have a 20% risk of further spinal compression fractures within 1 year after spinal compression fractures[1]. Therefore, when doing preoperative assessment of PKP in the future, clinicians should pay attention to demographic variables such as age and times of fracture, which regarded as independent risk factor of preoperative psychological disorder in OVCF patients.

This study found that patients with preoperative psychological disorder had corresponding worse physical function preoperatively as indicated by lower PROMIS PF scores at the preoperative baseline. This is consistent with previous literature that preoperative psychological disorder is associated with a patient's physical disability before spinal surgery[21–24]. Joon et al[21] demonstrated that patients with worse preoperative mental health were demonstrated to have worse preoperative PROMIS PF scores following minimally invasive transforaminal lumbar interbody fusion, what's more, patients with low mental health continue to report significantly worse physical function throughout the postoperative convalescence period. In this study, OVCF patients with preoperative psychological disorder are confirmed to have poor postoperative physical outcomes within 6 months following PKP procedures. However, no significant dysfunction was found in patients with and without psychological disorder 12 months postoperatively.

Back pain exists widely in patients with OVCF and reduce the life quality of patients[2]. Though PKP has been proved as an effective method in relieving pain of OVCF patients, postoperative residual back pain is still one of the important factors affecting patients' postoperative recovery[2–4]. It is well-known that added morbidity of depression and anxiety in orthopedic patients is strongly associated with more severe pain[25–27]. This study confirmed good efficiency of PKP in improving back pain in a short time, manifested as significant decrease of VAS scores within 1 month after operation in all patients with or without preoperative psychological symptoms. Meanwhile, patients with preoperative psychological symptoms experienced more severe low back pain not only at the preoperative baseline but also within 1 month after operation. So, paying attention to the preoperative psychological states may be effectively in reducing residual back pain following PKP.

PROMIS has proven to be effective in rapid evaluation of outcomes and reduce the burden of patients who complete the questionnaires due to its unique computer adaptive testing algorithm[12, 28]. PROMIS have been increasingly adopted in orthopedic and spine conditions to capture patient-centered indicators of health status for use in clinical care, research, and cost-effectiveness analysis[5–11]. When compared to traditional surveys, PROMIS provides a more efficient and accurate way reporting patient symptoms, function, and healthrelated quality of life[5, 6, 12]. Among these, the PROMIS Physical Function (PF) domain can particularly reflect the strength, range of motion and coordination of patients, so it provides utility in evaluation of postoperative function of patients with spine conditions. Therefore, PROMIS PF score was used to evaluate physical functions of patients following PKP procedures in this study.

Various preoperative factors were confirmed to influence postoperative outcomes following spinal surgery. But many preoperative characteristic, such as age and gender, are invariant, while others can be intervened preoperatively and used to improve postoperative outcomes of patients. There are evidences that early intervention of psychological states of patients with orthopedic conditions can reduce disability, improve outcomes of surgical interventions and medical procedures, reduce health costs and utilization[32, 33]. This study proved that preoperative psychological factors are significantly intercorrelated with back pain and physical function following PKP procedure, we suggest that giving early intervention to psychological states of OVCF may be an effective strategy in accelerating postoperative recovery, improving the life quality and satisfaction of surgery.

There are limitations to this study. First, this is a retrospective study. Second, the study is not generalizable because the number of patients in both groups was relatively small and the sample was from a single institution. In addition, the follow-up time of 1 year was designed according to most other studies. A longer follow-up study may provide a better understanding of the long-term influence of psychological states on recovery of OVCF after PKP surgery.

Conclusion

Psychological disorders such as depression and anxiety are widespread in patients undergoing PKP due to OVCF. Patients with poor preoperative psychological states not only demonstrated worse preoperative physical function and server back pain, but also continued to have worse postoperative outcomes. So, more attentions should be paid to psychological states prior to PKP in future treatments of OVCF.

Abbreviations

OVCF
osteoporotic vertebral compression fracture; PKP:percutaneous kyphoplasty; PPS:preoperative psychological symptoms; HAMD:Hamilton Depression Scale; HAMA:Hamilton Anxiety Scale; PROMIS PF:Patient-Reported Outcome Measurement Information System Physical Function; VAS:Visual Analogue Scales; BMD:bone mineral density; BMI:body mass index

Declarations

Funding

There is no funding source.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The Second Affiliated Hospital and Yuying Children's Hospital of Wenzhou Medical University Review Board. No consent was needed from any patients involved in this technical note.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no conflict of interest.

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Figures

Figure 1

Physical function of patients with and without preoperative psychological symptoms(PPS). * $p \leq 0.05$, ** ≤ 0.001 .

Figure 2

Back pain of patients with and without preoperative psychological symptoms(PPS). * $p \leq 0.05$, ** ≤ 0.001 .