A Tentative Study of Individual Puncture Path of PVP/ PKP in Treating OVCFs

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Abstract

Background: The prior objective of this study is to discuss individualized puncture path of percutaneous vertebroplasty (PVP) and percutaneous kyphoplasty (PKP) in the treatment of the elderly with severe osteoporotic vertebral compression fractures (OVCFs). Previous studies have compared the clinical efficacy and safety of PVP and PKP. Based on their research results, we will make a further investigation about this two main operations in treating OVCFs and propose a set of original and feasible puncture plan in clinical work, which will improve efficiency and safety of PKP and PVP.

Methods: We searched all the articles related to PVP and PKP in treating OVCFs on medicine database. Issues of the selected journals published from 1999 to 2020 were hand-searched by us, including experimental or review articles. Combining conclusions of these researches and clinical cases of our department, we are forged to find more common and preferred treatments for patients with OVCFs under different situations.

Results: Most of thees studies revealed that there was no significant difference in relieving the back pain and improving the quality of patients' life between PVP and PKP surgeries, which generally based on the VAS scores and Oswestry disability index(ODI) scores. However, PKP has a lower rate of bone cement leakage and incidence of adjacent vertebrae fracture than the PVP. Restoring the vertebral height and local kyphotic angle corrections of PKP are much better than that of PVP. On the other hand, more operation time, higher cost and rate of re-surgery of PKP should also be taken into consideration when we make better choice for patients. Therefore, we are forged to find individual methods for patients who are diagnosed as OVCFs.

Conclusions: Both the two types of operation can significantly relieve the pain of the patients ,reduce the risk of occurring complication and mortality after OVCFs. There is no so-called best treatment for patients between PVP and PKP. We should take the comprehensive actual conditions into account when choosing surgical methods for patients with OVCFs, which is absolutely vital to us. However, individual puncture path is beneficial for us to make operations including both PKP and PVP.

Introduction

With the process of aging society, osteoporosis is getting a very common disease and a tremendous threat to our health¹. Fragile bones and higher fracture risks are the characteristics of the osteoporosis, which have caused higher health care costs, physical disability, impaired quality of life, and increased mortality². Statistically the incidence of osteoporosis has reached at 36% in the population of the people over 60 years old³. Osteoporotic vertebral compression fractures (OVCFs) are recognized as the main cause of back pain and affect the quality of life in the aging people, which are one of the most common adverse clinical consequences of osteoporosis. Current treatments for OVCFs include conservative and surgical methods, such as the application of analgesics, anti-osteoporosis drugs, stay in bed , brace fixation, and rehabilitation. However percutaneous vertebroplasty (PVP) and percutaneous kyphoplasty

(PKP) are the main two types of surgery, which can rapidly relieve severe pain caused by fracture and restore the stability of spine⁴.

Previously, there were many studies in search of comparing the clinical efficacy and safety of PVP and PKP in the treatment of OVCFs. It was demonstrated that both PVP and PKP could immediately relieve severe pain and improve the quality of patients' life. The anterior height of vertebrae fractured and local kyphotic angle improved, which maintained at the last follow-up after PVP or PKP. But the operation time of PKP is longer than that of PVP, and PVP has lower cost. In view of the leakage of bone cement and the local kyphotic angle corrections, PKP seems to be better than PVP⁵. Which one is the best operation for treating OVCFs, it has not been totally clarified yet. We are willing to tentatively discuss the two operations and express our humble perspectives about puncture path in this papers.

Methods

1.1 Included Criteria 1)Patients are selected to investigated in our study from March to December 2020,who have been undergone PKP or PVP with OVCFs.2)The fractured vertebraes are located between T6 to L4.3)No surgical contraindications, PVP or PKP are completed under local anesthesia.4)All patients were informed of surgical methods and gave their consent.

1.2 Individual Design

All patients underwent a plain MRI (magnetic resonance imaging) scan of the thoracic and lumbar spine. The vertebral body showed edema and high signal combined with patients' symptoms and signs, which was confirmed to be the fractured vertebrae. Then anterior and lateral X-ray radiographs and CT scans of the corresponding parts should be performed. Design the puncture path based on the CT image, M is the midline and green line refers to the puncture path, figure out the skin and bone insertion points, measure the distance between the insertion point and the midline, and the angle A is important as well.(Fig.1)

Here, three parts of puncture processes should be emphasized. Angle A or B ,aside distance and the depth from needle to bone. Meanwhile, we need to attach great importance to three significant points as follow during operation .When the puncture needle reaches the bone insertion point, don't insert the needle immediately. We should reconfirm the accuracy of the cortical needle insertion point with the fluoroscopy. The inclination angle of unilateral puncture is tended to be slightly larger than that of bilateral puncture, for which the skin insertion point is more likely located outside and it is also safer to place the needle on the outer edge of the pedicle. Of course, it is beneficial for us to make adjustment with flexibility. In addition, when we see that the puncture needle reaches the inner wall of the pedicle from the anterior plain radiograph, it should be ensured that the puncture needle has reached the posterior wall of the vertebral body , which indicates that the puncture needle has not entered the spinal canal to damage the spinal cord or nerves. Next, the puncture needle will safely cross the inner edge of the pedicle and enter the anterior edge of the vertebral body. At this time, the whole process is finished when we see that the puncture needle has reached or slightly crossed the midline on the anterior plain film. This is a set of

standard procedures that can greatly improve the safety and effectiveness of the operation, which has been verified in our clinical practice. We choose to push injection at the drawing stage for achieving good distribution of bone cement. During the operation, it was found that the injection speed determined the pressure of cement entering the vertebral body. In order to reduce the risk of bone cement leakage, slow injection and fluoroscopy were used to maintain the push rod at the leading edge of the vertebral body. (Fig.2)

Results

Case One

An 82-years-old female was admitted to our hospital with a history of low back pain and limitation of movement, which occurred 4 days ago. Considering symptoms and physical findings, we tended to think that the severe LBP was mostly caused by OVCFs. Her diagnosis was identified by the result of imaging examinations. There were no constraints of operation for treatment. Based on the plain radiography and CT of the spine, we found that the fractured vertebrae has been severely compressed, for which we chose the bilateral percutaneous vertebroplasty operation. The puncture needle was likely to reach or slightly cross the midline between the front and middle of the vertebral body. Postoperatively, the patient was recovered rapidly and discharged from hospital soon. The plan and outcome was shown followed.(Fig.3)

Case Two

An 71-years-old female was presented with recurrent low back pain for about 1 year and aggravation with immobilization for 10 days. Imaging revealed a compression fracture at the T12 vertebrae. It was the collapse of the vertebral body is mainly located in the middle that we have chosen bilateral PKP. What's the same, the puncture site of the needle was better to reach the first half of the vertebral body but should not exceed the first third. After unilateral PKP surgery, the patient's severe pain has relieved a lot and physical examination revealed good health status. (Fig.4)

Discussion

The OVCFs, which are mainly caused by osteoporosis, have become a major health problem worldwide and led to disability in aging populations, and induced great losses both socially and economically. Although most OVCFs can be healed within a few months by conservative therapy, surgical treatment such as PVP or PKP should be regarded as a better choice because of the fatal complications to the aging patients. Hulme et al reported that approximately 95% pain and dysfunction caused by fracture can be relieved a lot by these two methods⁶. Both PVP and PKP are recognized as the effective procedures in the treatment of OVCFs, which can immediately relieve the back pain and improve the quality of life. However, studies regarding with the outcomes of PVP or PKP in the treatment of OVCFs are limited. Yet, it is not clarified that which one of PVP and PKP is more effective for the treatment of OVCFs, because few comparative studies have been carried out. According to the limited but available information, it was

concluded that there was no significant difference between PVP and PKP in relieving pain and improve the quality of life. However, the mean anterior height of vertebrae fractured and local kyphotic angle in PKP group were restored better than those in PVP group at 1 day after surgery and the last follow-up. Meanwhile, PKP has a lower rate of bone cement leakage. Nevertheless, the PKP surgery usually spends more time, with complicated operational steps, which means more exposure time and higher cost. Besides, people have investigated that patients with low BMD, or undergoing PKP, or receiving a low volume of injected cement might have a high risk of re-collapse in surgical vertebrae⁷. Above all, I want to make it clear that there is no optimal approach to treat OVCFs but there are better choices we can make for patients.

Clinically, if we want to get a good surgery outcome, it is necessary for us to reach the following standards. Firstly, bone cement volume and distribution play an significant role in percutaneous kyphoplasty (PKP), which is involved in keeping the vertebral stabilization and curative effect. Previous studies have shown that a cement distribution above 0.49 with a small cement volume should be suggested for PKP⁸. An extensive cement distribution is markedly correlated with the efficacy to improve the kyphotic angle and restore the anterior height of compressive vertebrae, and it is not involved with cement leakage or adjacent vertebral fractures. The volume of injected bone cement is recognized as an important factor of surgery procedure. Relative study focused on the association between the cement volume and the restoration of vertebrae biomechanical characteristic has proved that about 16% cement volume filling can restore vertebral strength, while approximately 29% cement volume filling can restore vertebral stiffness⁹. Generally speaking, puncture approach and the surgical segments are both related to injected bone cement volume. Lots of reports show that bipedicular approach and lumbar vertebral fracture will use more bone cement than unipedicular approach and thoracic vertebral fracture. While, it is also reported that the puncture point is an another key factor to form a distribution of bone cement in anterior and middle area in the vertebral body. Secondly the puncture way can be conducted well without navigated devices under our clinical experience. The procedures also have been simplified. We can make a preliminary plan on computer and paper before operation time. Patient's imagings of CT, printed on the A4 paper, can be used as blueprints for our measurements. We make a triangle with the midline of the vertebral body as the height, of which both sides do not exceed the medial edge of the spinal canal. The vertex of the triangle can be any point of the front two-thirds of the midline. Puncture in this range, the outcomes of PKP or PVP are always better than our plans because of excellent efficacy of cement distribution. Lastly the traditional surgical method is bilateral pedicle puncture for bone cement injection, which has the disadvantages of long operation time and much more time of fluoroscopy, and bigger intraoperative blood loss. Unilateral pedicle puncture can avoid the above shortcomings and has the same clinical effect with bilateral puncture¹⁰.

Conclusion

All in all, detailed preoperative planning, standardized operations and summary of experience are the key factors for us to improve the efficiency, safety and effectiveness of PKP/PVP in the treatment of OVCFs

without auxiliary puncture or electronic endoscopic visualization equipment. Last but not least, appropriate surgical method should be selected for different patient under the specific situation. However, we are likely to get good outcomes according to the following six conditions.(Fig.5)

Abbreviations

OVCFs: severe osteoporotic vertebral compression fractures

PKP: percutaneous vertebroplasty

PVP: percutaneous kyphoplasty

Declarations

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Authors' contributions

GS performed the measurements and statistical analysis and prepared the manuscript. **XCM** and **WCL** performed study design and prepared the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The data and materials used and/or analyzed during the current study are not publicly available but available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study was conducted in accordance with the 1964 Declaration of Helsinki and its later amendments/clarifications and with approval from the Ethics Committee of Hospital(T.C.M) Affiliated to Southwest Medical University , China on 15 June 2021. The patients were informed that data from the case would be submitted for publication, and gave their consent.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no conflicts of interest.

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Figures

Figure 1

All patients underwent a plain MRI (magnetic resonance imaging) scan of the thoracic and lumbar spine.

Preoperative design of puncture path

Reach the bone insertion point

Reach the inner edge of pedicle

Reach the anterior middle 1/3 of the vertebral body

Figure 2

In order to reduce the risk of bone cement leakage, slow injection and fluoroscopy were used to maintain the push rod at the leading edge of the vertebral body.

Figure 3

The whole surgery process of patient in case one.

Figure 4

The whole surgery process of patient in case two.

Figure 5

Tips from our clinical work.