

Diagnosis and Treatment and Infection Protection Strategy of Osteoporotic Vertebral Compression Fractures Minimally Invasive Percutaneous Kyphoplasty Surgery during the Prevention and Control of COVID-19

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Abstract

Background: As the global novel coronavirus pneumonia (NCP) remains severe, elderly people are at high risk for NCP and osteoporotic vertebral compression fractures, with high complications and mortality. How to treat patients and protect medical staff from infection, and at the same time strictly prevent the occurrence of clustered transmission events in the hospital, the establishment of perfect pre-hospital emergency measures and infection prevention and control strategy is the first element to ensure success. **Objective:** To establish the diagnosis and treatment and infection protection strategy for Osteoporotic vertebral compression fractures (OVCF) patients undergoing minimally invasive percutaneous kyphoplasty (PKP) surgery during the prevention and control of COVID-19, so as to ensure the stable, orderly and safe medical treatment. **Methods:** A total of 583 OVCF patients were admitted to the First Affiliated Hospital of Hebei North University during the epidemic prevention and control period from January 2020 to July 2022. After urgent and outpatient strict standardized screening, 382 patients met the inclusion criteria, including 112 males and 270 females, aged (70.50 ± 5.49) years. The preoperative visual analogue scale (VAS) score was 6.92 ± 1.86 . Preoperative Oswestry disability index (ODI) was 74.67 ± 4.84 . The satisfaction rate was (45.89 ± 3.67) %. According to the clinical diagnostic criteria and classification, 367 patients were diagnosed as ordinary OVCF, including 156 cases of mild compression and 226 cases of moderate compression. The clinical classification of 15 patients with OVCF diagnosed as COVID-19 was type I, includ-

ing 10 cases of mild COVID-19 and 5 cases of common COVID-19. All patients were treated with PKP. **Results:** All patients were followed up at 1 day, 1 month and 3 months after operation, VAS (2.01 ± 0.56 , 0.45 ± 0.11 , 0 ± 0), ODI (45.41 ± 4.15 , 10.22 ± 2.73 , 4.03 ± 1.57) and satisfaction (90.12%, 95.57%, 99.23%) were significantly improved compared with those before operation ($p < 0.05$), and the original medical diseases were not aggravated. In this group, 15 cases of OVCF diagnosed with COVID-19 were given priority to treat COVID-19 under strict three-level protection in the designated isolation ward. PKP was carried out after the condition was stable, and the areas, items and personnel in contact with patients during the perioperative period must be strictly and thoroughly disinfected. The patient had a good prognosis, no complications, no cross-infection in the hospital, and no infection rate among medical staff. **Conclusions:** The implementation of the diagnosis and treatment and infection protection strategy for OVCF patients undergoing minimally invasive PKP surgery during the prevention and control of COVID-19 has a guiding role in preventing the spread of infection, improving the cure rate, promoting rapid recovery, reducing complications and reducing mortality.

Keywords

COVID-19, Osteoporotic Vertebral Compression Fractures, Diagnosis and Treatment, Percutaneous Kyphoplasty, Operating Room Management, Infection Protection

1. Introduction

Osteoporosis Vertebra Compressed Fracture (**OVCF**) is a vertebral compression fracture caused by osteoporosis, and its incidence is increasing year by year. Global incidence was 15.6%, which has the highest incidence of 34.8% in Europe [1]. Complications such as hypostasis pneumonia, pressure sores and deep vein thrombosis of lower limbs occur due to severe back pain and long-term bed rest. In addition, it leads to the aggravation of various diseases in the elderly, and the mortality rate increases by 23% - 34% compared with those without OVCF [2] [3]. Percutaneous kyphoplasty (**PKP**), as a minimally invasive procedure, can make OVCF patients recover quickly, reduce complications and reduce mortality [4] [5]. Novel coronavirus pneumonia (NCP), named 2019 Corona Virus Disease (COVID-19) by the World Health Organization (WHO), spreads rapidly, is virulent and the population is generally susceptible. In particular, the elderly are susceptible to more complications and high mortality. The incubation period of COVID-19 is 1 - 14 days, up to 24 days [6]. OVCF and COVID-19 are both prone to diseases of the elderly, and it is necessary to treat patients with PKP indications during the epidemic prevention and control. However, there may be virus carriers or asymptomatic infection in these fracture patients. Orthopaedic surgeons should pay enough attention to prevent the occurrence of nosocomial cluster transmission events. It is of great significance to establish the diagnosis and treatment and

infection protection strategy for OVCF patients undergoing minimally invasive surgery during epidemic prevention and control. From January 2020 to July 2022, 580 OVCF patients were admitted to the hospital during the COVID-19 epidemic prevention and control period. Through the standardized examination process of emergency and outpatient department, OVCF patients excluded or confirmed with COVID-19 were classified according to the degree of disease, and the diagnosis, treatment and perioperative infection protection strategies were formulated to achieve good clinical results. The prognosis of the patient is good, there is no cross-infection in the hospital, and the infection rate of medical staff is zero. The experience is summarized as follows.

2. Data and Methods

2.1. Inclusion and Exclusion Criteria

Inclusion criteria: 1) age ≥ 65 years old; 2) OVCF was diagnosed preoperatively according to medical history, X-ray, CT, MRI and bone mineral density examination; 3) No spinal cord nerve injury; 4) MRI showed that the injured vertebral body was fresh compression fracture; 5) PKP under local anesthesia.

Exclusion criteria: 1) infection at the percutaneous puncture site; 2) Abnormal coagulation function; 3) combined with spinal cord nerve injury; 4) Severe compression fracture: the compression ratio of the upper thoracic spine exceeds 50%, and the compression ratio of the lower thoracic and lumbar spine exceeds 75%; 5) Those requiring open surgical treatment.

2.2. General Information

A total of 583 OVCF patients were enrolled in the First Affiliated Hospital of Hebei North University from January 2020 to July 2022, and 382 patients met the inclusion criteria, including 112 males and 270 females, aged (70.50 ± 5.49) years and weighing (61.43 ± 19.57) kg. The range of vertebral fracture was T4 to L5, and the preoperative visual analogue scale (VAS) score was 6.92 ± 1.86 . The preoperative Oswestry disability index (ODI) was (74.67 ± 4.84) %, and the satisfaction rate was (45.89 ± 3.67) %. All patients had thoracolumbar back pain, vertebral kyphosis, functional limitation, decreased quality of life and various medical disease manifestations. After urgent and outpatient strict standardized screening, they were admitted to the hospital and treated with PKP minimally invasive surgery under local anesthesia. This study complied with the ethical principles and limitations of the Declaration of Helsinki [7], and was approved by the Medical Ethics Committee of our hospital (approval No.: W2020013). All enrolled patients signed informed consent.

2.3. Methods

2.3.1. Screening Methods for Patients with Osteoporotic Vertebral Compression Fractures in the Emergency and Outpatient Clinics before Admission

During the epidemic prevention and control period, emergency and outpatient

medical staff were protected according to the three-level COVID-19 protection measures, and 583 patients with OVCF as the first symptom should be considered as suspected patients in emergency and outpatient clinics. Screening for COVID-19 was conducted according to the COVID-19 Prevention and Control Protocol (ninth edition) [6], and relevant tests and examinations were conducted according to the flow chart for emergency and outpatient screening of OVCF patients suspected of COVID-19 (see **Figure 1**). All patients underwent nucleic acid testing, blood routine, ESR, CRP, procalcitonin, D-dimer, blood biochemistry, X-ray, CT (including chest), MRI (thoracolumbar spine). For OVCF patients diagnosed with COVID-19, they should visit the fever clinic, and apply for spinal surgery consultation in the fever clinic. In addition, Personal level 3 protection for medical personnel should be done in advance [8]. All COVID-19 patients (including suspected and confirmed patients) are strictly isolated in designated medical institutions.

2.3.2. Diagnostic Criteria

The diagnosis of OVCF is mainly based on the patient's age, gender, menopause history, brittle fracture history, clinical manifestations, imaging and/or bone mineral density examination results. The typical symptoms of OVCF are low back pain, physical examination shows limited spinal movement, fractured vertebral tenderness and percussion pain, kyphosis and loss of height. The diagnosis of OVCF is mainly based on imaging findings that the height of the anterior, middle or posterior vertebral body decreases by more than 20%, or the height of the vertebral body decreases by 4 mm compared with the baseline vertebral body [9]. Clinically, it is divided into mild, moderate and severe OVCF. Mild OVCF compression is 20% - 25% at the height of the original vertebral body, moderate OVCF compression is 25% - 40%, and severe OVCF compression is more than 40% [9]. All 382 patients met the diagnostic criteria of mild and moderate OVCF.

A diagnosis of COVID-19 must meet any of the following criteria [6]: 1) 2019-nCoV nucleic acid was positive by RT-PCR; 2) Viral gene sequencing, highly homologous to the known 2019-nCoV. In the early stage of COVID-19, the peripheral blood lymphocyte count of most patients decreased, and C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) increased. 2019-nCoV nucleic acid can be detected in nasopharyngeal swabs, sputum, lower respiratory tract secretions, blood, stool and other specimens. Chest CT showed signs of pneumonia. COVID-19 is clinically divided into mild, common, severe and critical types [6]. **Mild type:** the clinical symptoms are mild, and there is no evidence of pneumonia on imaging. **Common type:** with fever, respiratory symptoms, imaging can be seen pneumonia. **Severe type:** 1) Respiratory rate ≥ 30 times/min; 2) Oxygen saturation $\leq 93\%$ in resting state; 3) arterial partial pressure of oxygen (PaO₂)/oxygen uptake concentration (FiO₂) ≤ 300 mmHg (1 mmHg = 0.133 kPa); 4) Lung imaging showed significant lesion progression $> 50\%$ within 24 to 48 hours. **Critical type:** 1) Respiratory failure and need mechanical ventilation; 2) The appearance of shock; 3) Patients with other organ failure need ICU care and treatment.

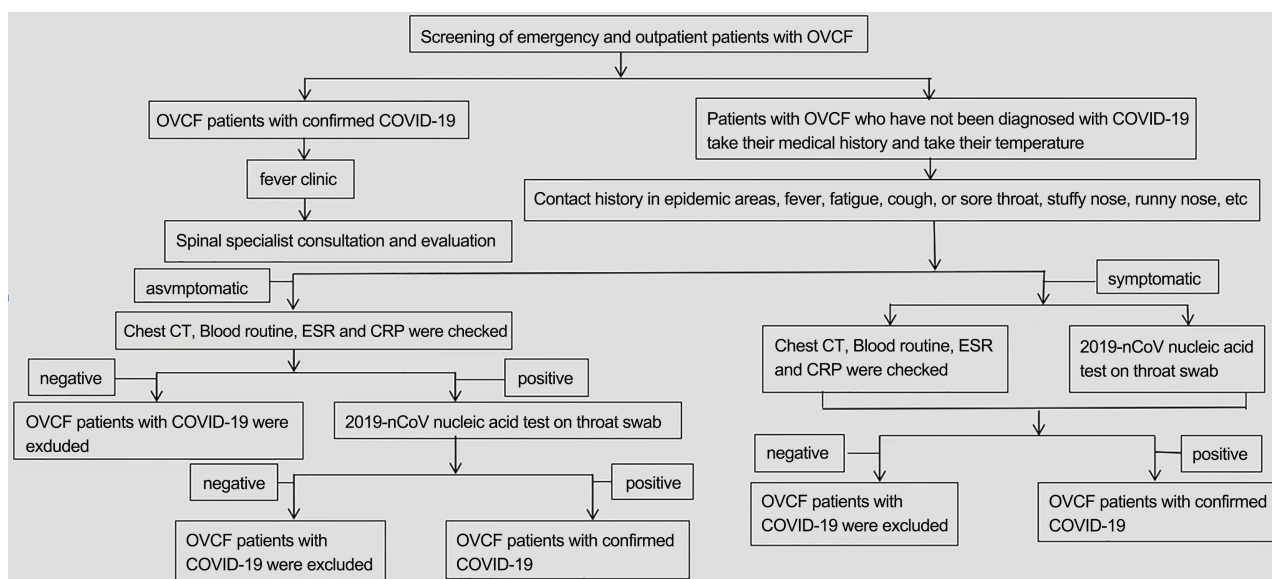


Figure 1. COVID-19 screening process for urgent and outpatient visits in OVCF patient.

2.3.3. Clinical Classification Criteria for Osteoporotic Vertebral Compression Fractures Patients with COVID-19

OVCF patients diagnosed with COVID-19 were comprehensively classified according to the degree of osteoporotic spinal compression fracture combined with the degree of COVID-19. The classification criteria were as follows: 1) Mild and moderate were defined as type I: Mild to moderate OVCF is associated with mild to common COVID-19. 2) Severe is type II: divided into three subtypes, 1) Type IIa: severe OVCF with neurological dysfunction, while COVID-19 is mild and common; 2) Type IIb: mild or moderate OVCF with severe COVID-19; 3) Type IIc: severe OVCF with neurological dysfunction, while COVID-19 is severe; 4) Critical type is type III: no matter what degree of OVCF, as long as COVID-19 is clinically critical. In this study, 15 OVCF patients with COVID-19 met the clinical classification criteria of type I.

2.3.4. Treatment Methods

For OVCF patients with COVID-19 excluded, PKP was performed under local anesthesia and C-arm X-ray fluoroscopy after all preoperative examinations were completed. Fifteen OVCF patients with confirmed COVID-19 were treated with multidisciplinary assistance in the isolation ward of the designated hospital, with priority for COVID-19 treatment, and PKP was performed in the specific operating room of the isolation area under three-level protection after the condition stabilized. As long as medical conditions allowed, all patients were able to get out of bed 12 hours after surgery under the protection of thoracolumbar braces, and medical therapy (calcium tablets + vitamin D + anti-osteoporosis drugs) was carried out throughout.

3. Result

Among the 382 patients who met the OVCF inclusion criteria, 156 patients with

mild compression and 226 patients with moderate compression were followed up on the first day, one month and three months after operation respectively. VAS (2.01 ± 0.56 , 0.45 ± 0.11 , 0 ± 0), ODI (45.41 ± 4.15 , 10.22 ± 2.73 , 4.03 ± 1.57) and satisfaction (90.12%, 95.57%, 99.23%) were significantly improved compared with those before operation ($p < 0.05$), and the original medical diseases were not aggravated. Of the 382 patients in this group, 15 were diagnosed with OVCF of COVID-19, and the clinical classification was type I, including 10 cases of mild COVID-19 and 5 cases of common COVID-19. Standardized treatment of COVID-19 was performed under strict three-level protection in the designated isolation ward, and PKP was performed after the condition was stable. The areas, articles and personnel in contact with patients after operation must be strictly and thoroughly disinfected. The patients had no complications, and the prognosis was good. There was no cross infection in the hospital, and the infection rate of medical staff was zero.

4. Discuss

Both OVCF and COVID-19 are diseases prone to occur in the elderly during the epidemic prevention and control period. Most elderly patients have multiple underlying diseases, which are more likely to lead to complications. OVCF patients diagnosed with COVID-19 have a high mortality rate if they are not treated in time. If the treatment is not standardized, the prognosis is poor, infection transmission, and nosocomial cross infection. Therefore, it is a new challenge for orthopedic surgeons to deal with this special group during the COVID-19 epidemic. The establishment of standardized diagnosis, treatment and infection protection strategies for OVCF during the epidemic prevention and control of COVID-19 can enable orthopedic surgeons to master the admission screening process, diagnostic criteria and correct clinical classification. The implementation of standardized and effective treatment and perioperative protection strategies is a key link to ensure the efficacy of OVCF patients with COVID-19 and prevent infection transmission.

4.1. Make Treatment Principles and Individualized Plans for Osteoporotic Vertebral Compression Fractures Patients during the Epidemic According to Clinical Classification

Therapeutic principles For OVCF patients who have been excluded from COVID-19, the specific treatment plan shall be implemented according to the OVCF treatment guidelines during non-epidemic period [10]. Under the current epidemic prevention and control, the treatment methods for OVCF patients confirmed with COVID-19 include non-surgical treatment and surgical treatment. The general treatment principles are as follows: 1) Under the condition of giving priority to COVID-19 prevention and control, non-surgical or surgical treatment strategies should be formulated according to the clinical classification of patients. Non-surgical treatment should be adopted for types I, IIa and IIb, non-surgical treatment should be preferred for type IIc, or surgical treatment

should be performed when the condition of COVID-19 is stable, and absolute surgical contraindication should be made for type III. At this time, treatment was carried out according to the COVID-19 critical protocol. 2) Surgical treatment still needs to be cautious. The basic principles are as follows: strictly grasp the surgical indications, and try not to perform surgery if possible; Can do small surgery as far as possible not to do major surgery, can do minimally invasive surgery as far as possible not to do open surgery; 3) Implement network multidisciplinary collaboration diagnosis and treatment (MDT) to achieve the purpose of individualized treatment for OVCF patients in line with the background of epidemic prevention and control.

Individualized treatment regimens were implemented according to the clinical classification of OVCF patients confirmed with COVID-19: **1) Type I:** It is recommended to give priority to the isolation ward for preventive isolation and COVID-19 treatment, and non-surgical treatment for OVCF, including psychological care, dietary care, health education, reasonable analgesia, bed rest, appropriate activities under brace protection and drug therapy (calcium tablets + vitamin D+ anti-osteoporosis drugs). The reasons for not giving priority to minimally invasive surgery, namely percutaneous vertebroplasty (PVP) and percutaneous kyphoplasty (PKP), for such patients are: firstly, it does not interfere with the priority treatment of COVID-19; secondly, it prevents contamination of non-infected areas such as non-infected wards and operating rooms and reduces the risk of cross-infection in the hospital. **2) Type II:** a) **Type IIa** If no surgical treatment will cause serious consequences to the patient after full evaluation before surgery and multidisciplinary consultation, minimally invasive surgery (PVP or PKP) under local anesthesia should be preferred under strict whole-process protection conditions, and immediately transferred to the infectious ward for COVID-19 treatment after surgery. b) **Type IIb** Severe COVID-19 is a contraindication for surgery, and it is recommended to give priority to the isolation ward for COVID-19 treatment, while non-surgical treatment for OVCF. c) **Type IIc** The treatment is the same as type IIb, and active treatment of COVID-19 is given priority. Non-surgical treatment is given to OVCF, and spinal fracture surgery is performed after COVID-19 is stable or cured. **3) Type III** the critical type of COVID-19 is an absolute contraindication for surgery. Under the three-level protection conditions of ICU, priority should be given to saving patients' lives, actively treating COVID-19, and preventing infection or cross-infection in the hospital [11].

4.2. Establish Operating Room Management and Protection Strategies for Osteoporotic Vertebral Compression Fractures Patients with COVID-19

When the MDT medical team discusses and decides to take surgical treatment for OVCF patients with confirmed COVID-19, corresponding protective preparations and measures should be made in the anesthesiologist department, operating room and during transportation. It is particularly important to reduce no-

socomial infection, prevent the local spread of the epidemic, and do a good job in the whole perioperative protection of COVID-19 patients [12].

Preoperative management and protective strategies Surgical patients diagnosed with COVID-19 shall be escorted by special transport vehicles after wearing protective equipment by the operating room shuttle staff and sent to the special isolation area set up in the operating room through special channels and elevators to avoid contamination of the operating room. Surgical procedures should be carried out in a special infection-free operating room with negative pressure or radiation protection (intraoperative X-ray fluoroscopy is required). The operation can be carried out only when the negative pressure difference between the operating rooms is kept below -5 Pa [13]. All personnel participating in the operation were dressed according to three levels of protective standards: double disposable hats, N95 masks, disposable isolation surgical gowns and medical protective clothing, goggles and/or face mask, and double sterile gloves [14]. All medical supplies follow the principle of special personnel.

Intraoperative management and protective strategies Intraoperative anesthesia to maintain sedation, muscle relaxation, reduce bucking. Isolation and protection should be strengthened during the operation, and patients' blood, secretions, excreta and possible aerosols should be protected during the operation [15]. Medical workers are not allowed to leave the isolation area wearing protective equipment, and should leave through a special channel after taking off protective equipment.

Postoperative management and protective strategies After the operation, the medical staff must first change the gloves, and then remove the operating gown and shoe cover and discard them in the medical waste bucket. After taking off the gloves, the standard hand disinfection should be carried out immediately, and the goggles, protective clothing, masks and hats should be removed in the buffer room of the operating room before leaving the operating room. Staff leaving the operating room must again wash their hands, disinfect their hands and wash their faces, as well as disinfect their noses. Patients were transported to designated wards for isolation and treatment according to specific routes. Items, walls, floors, transport vehicles and medical waste in the operating room must be strictly and thoroughly disinfected after operation; After disinfection treatment, sampling and testing are carried out, and the results can be used again only after passing [16] [17]. It is recommended that the operating room be closed for more than 24 hours before the next operation can be carried out.

Postoperative Management of Wards Ordinary patients can be transferred to the general ward for continued treatment after surgery, but the precautions related to ward protection mentioned above should be strictly followed. Those with respiratory symptoms or fever after surgery should be isolated according to the criteria of suspected COVID-19, and nucleic acid test, chest CT, blood routine test, ESR, CRP, procalcitonin, D-dimer and blood biochemical test should be performed. Suspected or confirmed patients should be transferred to the des-

ignated isolation and care unit after surgery. When medical staff enter the isolation ward for diagnosis and treatment, they must strictly observe the third level of protection.

In conclusion, in order to reduce the risk of cross-infection among patients, patients and medical staff, and medical staff, and improve the prognosis of OVCF during the epidemic prevention and control period, it is necessary to coordinate the diagnosis and treatment of infectious diseases and OVCF through multidisciplinary collaboration for scientific treatment of OVCF patients with COVID-19. It is of great significance to formulate strict diagnosis, treatment and infection protection strategies, focus on epidemic prevention and control and medical services at the same time, and do a good job in the treatment of patients undergoing OVCF minimally invasive surgery during epidemic prevention and control, which will prevent the spread of infection, improve the cure rate, promote rapid recovery, reduce complications and reduce mortality. The shortcomings of this study lie in the single center study, the number of cases is relatively small, the follow-up time is short, and the long-term efficacy needs to be further observed.

Foundation Items

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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