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Original Research

The filling proportion of bone cement affects recollapse of vertebrae after percutaneous vertebral augmentation: A retrospective cohort study

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HIGHLIGHTS

- Determine the relationship between filling proportion of bone cement in the vertical direction and incidence of recollapse.
- Assess the effect of vertebral augmentation from the perspective of radiology.
- We designed a new method to avoid the measurement bias of taking photos and checking methods.

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ABSTRACT

Background and objectives: The aim of this study was to determine the relationship between filling proportion of bone cement in the vertical direction and incidence of recollapse in the augmented vertebrae after vertebral augmentation.
Methods: Fifty-one patients (51 vertebrae) who had operations between January 2014 and July 2016 with a mean age of 78.10 years were included. All patients in our department of spine surgery were advised to have follow-up care every 6 months. Patients characteristics, radiographic outcomes were evaluated.
Results: The recollapse of augmented vertebral body occurred in 10 of 51 vertebrae (20%).
Conclusion: Patients with a high proportion rate of bone cement in the middle vertical direction have a low incidence of experiencing recollapse.

1. Introduction

During the past decades, osteoporosis vertebral compression fractures(OVCFs) has become an increasingly common and costly global public health problem [1,2]. Percutaneous vertebral augmentation, including kyphoplasty(PKP) and vertebralplasty(PVP) was extensively used as an alternative rather than traditional conservative treatment methods including oral medications and immobilization [3–5]. Patients predictably demonstrate rapid and approving pain relief and improve function and quality of life [6]. Despite the demonstrated benefits, as a treatment modality for ongoing painful OVCFs, subsequent collapse of augmented vertebral body with significant vertebral height loss and exaggeration of the kyphotic deformity was observed. Previous attempts have been made to identify risk factors that can be used to predict new recompression after vertebral augmentation to prevent the occurrence of the implications. However, results of these studies have been diverse and conflicting.

Vertebral augmentation leads to an instantaneous regain of stability and strength and thus prevent continuous micro-motion and further collapse of fractured vertebrae, nonetheless, it has been observed that vertebral body recollapse did set in with significant vertebral height loss. Several studies have reported newly developed collapse in the augmented vertebrae after PKP and PVP and affecting factors [7,8]. However, a few researchers paid close attention to the risk factors of recollapse of augmented vertebral body after PVP and PKP.

Therefore, the aim of our study was to explore the percentage of filling rate of bone cement and other factors that may affect delayed

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vertebral collapse in patients with successful vertebral body augmentation after OVCFs. This could help identify patients at higher probability of recollapse, for whom the proper approach could be taken from the surgery.

2. Material and methods

2.1. Patients

Fifty-one patients who underwent procedure with vertebral body augmentation, including PVP and PKP for OVCFs between May 2014 and November 2016 in the Department of Spine Surgery of our hospital were recruited. All patients were confirmed to have a radiological diagnosis of OVCFs from MRI. A total of 13 patients underwent PKP, and 38 patients underwent PVP.

In order to rule out bias in the recruited patients, the inclusion criteria were as follows. 1) each patient had a single-level OVCF at T10 or lower; 2) acute or sub-acute fracture (fracture age <6 weeks); 3) oedema in the fractured vertebral bone marrow was found on magnetic resonance imaging (MRI); 4) follow-up period of 6 months or 12 months (all patients in our department of spine surgery were advised for follow-up care every 6 months); 5) without complications, such as polymethylmethacrylate (PMMA) leakage, post-operative neurologic deficit and pulmonary embolism. 6) had the 6 months or longer follow-up time care. Exclusion criteria were 1) more than one-level OVCFs; 2) pathologic vertebral fracture due to malignancy and additional posterior spinal instrumentation; 3) clinically significant neurologic deficit exist before and after the surgery; 4) presence of subsequent fracture after vertebral body augmentation at adjacent vertebrae. 5) L5 vertebrae fracture (we need to measure the anterior heights of adjacent vertebra both above and below the fracture vertebrae to calculate the height of augmented vertebrae, details in section 2.3).

In the fifty-one patients, there were ten patients been observed with the presence of subsequent recollapse through radiography. The enrolled patients were classified into the following two groups, Group A: patients with recollapse of the augmented vertebral body, and Group B: patients without recollapse of the augmented vertebral body.

2.2. Surgical procedures and postoperative care

Kyphoplasty: Just like other previous reports [9,10], the height of fractured vertebra was restored by an expandable balloon via bilateral transpedicular approach according to routine procedures using PMMA cement via bilateral portals according to routine procedures and under local anesthesia. Vertebralplasty [3,11]: PMMA was injected into the vertebral body via bilateral portals to strengthen it according to routine procedures. Early ambulation was permitted as soon as possible after procedure. Calcium, vitamin D and bisphosphonates were followed for all patients after surgery.

2.3. Radiological assessment

The recollapse of the augmented vertebral body was defined by lateral X-ray imaging. The follow-up lateral X-ray imaging presenting any anterior, middle or posterior body height loss greater than 3.0 mm compared to day 1 after surgery was defined as recollapse [12].

All patients in our center were advised to have follow-up care via an outpatient clinic every 6 months after surgery for evaluation of postoperative results. To evaluate the radiological results of vertebral body augmentation, we checked immediate post-operative, and every 6-months follow-up X-ray radiographies. Preoperative magnetic resonance imaging was used to find the fracture and determine the responsible vertebrae. The images were measured on standard erect lateral radiographs by methods following as shown in Fig. 1: 1) the height of bone cement in the anterior 1/3, middle 1/3 and posterior 1/3 vertebral body. 2) measure the height of anterior, middle and posterior vertebral body including day1 after surgery and 6months follow-up examination respectively; 3) the ratio of the height of cement located in the anterior vertebral wall to the height of the anterior vertebral body. 4) the ratio of the height of cement located in the middle vertebral wall to the height of the middle vertebral body.5) the ratio of the height of cement located in the posterior vertebral wall to the height of the posterior vertebral body.

During the process of taking X-ray images at follow-up time after surgery, patients different locations away to initial locations will result in different measurements, despite taking use of the same machine (Fig. 2). To avoid the measurement bias of taking photos and checking methods, we designed a new formula to measure vertebral heights: Besides measuring the heights of augmented vertebra, correspondingly we measured the anterior heights of adjacent vertebra. And so, we excluded the L5 vertebral fracture in our study. If the difference between the two measurements of anterior heights (day 1 and follow-up) is less than 0.1 cm, we accepted the direct measurement results. On the contrary, if the difference between the two measurements of the both adjacent anterior heights are greater than 0.1 cm, we considered that there was a measurement error resulting from taking X-ray images as shown in Fig. 2. Then the final measurement results were calculated by the formula:

$(a+b)/(a'+b') = h'/h \Rightarrow h = h'(a'+b')/(a+b)$. Fig. 3 presents.

2.4. Statistical analysis

Each parameter was measured and analyzed twice by the authors individually and independently to reduce intra- and inter-observer bias, and then used the averaging. If there was an apparent difference in any result, the authors conferred to decide the final data. Clinical data including age, gender, follow-up time, operation method, unilateral or bilateral were statistically analyzed. Radiological data including total cement volume, immediate post-surgery vertebral heights, vertebral body heights at follow-up and R(ratio) were also analyzed statistically. Continuous variables were reported as means and standard errors or median,

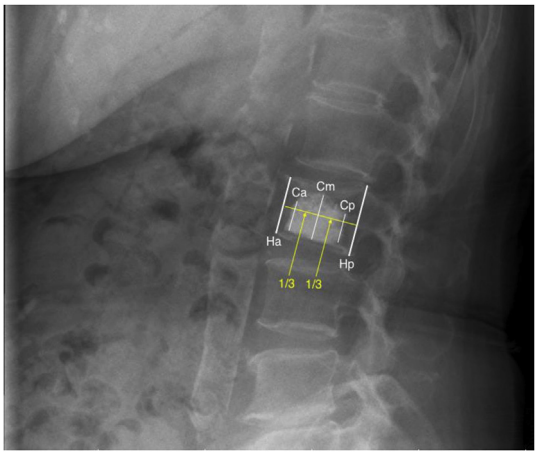

Fig. 1. Measuring the height of bone cement and vertebra through standard erect lateral radiograph.