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Original Article

Complications of Percutaneous Vertebroplasty

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BACKGROUND: Vertebral fractures are common pathologies encountered in neurosurgical practice. It has different origins; osteoporotic, traumatic, or neoplastic. Percutaneous vertebroplasty (PVP) is a procedure used to treat the pain associated with these fractures. This procedure has different complications including cement leakage, which can occur intravenous, into the paravertebral soft tissue, into the intervertebral disc or into the spinal canal affecting foraminal area or epidural space.

OBJECTIVE: The aim of this study was to assess the results of vertebroplasty using polymethylmethacrylate cement (PMMA) in 100 patients (120 vertebrae) and its complications.

METHODS: A retrospective clinical study of hundred patients with hundred and twenty PVP levels. Sixty patients of the group were osteoporotic. Thirty patients had history of malignancy. Two patients' imaging showed vertebral haemangiomas and posttraumatic fractures were noticed in eight subjects. Patients were operated between 2010 and 2019 at Suez Canal University Hospitals (Ismailia, Egypt). There were seventy (70%) women and thirty men (30%). The age range of our patients was between 24 to 74 years, their mean age was 58 years. Forty-five patients were operated on at a single level while fifteen subjects had double to triple levels fractures.

RESULTS: All our patients had significant back pain with high visual analogue scale (VAS) (70-100), with a mean of ninety-three. Twelve hours postoperatively, 95% of the patients reported pain relief with a VAS mean score of 35. Complications were noticed in 37.5% in all procedures. Leakage occurred in 35% in patients with osteoporosis, 20% in patients with neoplasms and 12.5% in traumatic fractures. Also, three patients had leakage in the spinal canal.

CONCLUSION: Vertebroplasty is a minimally invasive surgical technique with a low risk of complications. In more than 95% of patients, vertebroplasty effectively decreases pain. Nearly 40% of patients experience local problems. However, in over 90% of these problems, there was no effect on long term outcomes.

KEYWORDS: Cement leakage, Compression fractures, Neoplastic fractures, Osteoporotic fractures, Percutaneous vertebroplasty.

INTRODUCTION

Percutaneous vertebroplasty (PVP) is a minimally invasive procedure for treating pain caused by vertebral fractures of various types, including osteoporotic, traumatic and neoplastic fractures.[1,2] Complications are not uncommon; however, they are usually not clinically significant.[1-3] Cement leakage can occur intravenously, paravertebrally, into the intervertebral disc, or into the spinal canal, disrupting the foraminal area or epidural space,[3-5] while intradural leaking is quite uncommon.[6] PVP can also raise the risk of neighboring vertebral fractures[4,7]

Infections following surgery are uncommon,[8] and serious systemic complications are very rare,[9] but sometimes are fatal like fat embolism,[10] pulmonary embolisms,[11] cardiac injury,[12] or arterial,[13] or renal embolization.[14] Epidural bleeding exists; however, it is quite uncommon.[15]

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There are numerous publications on the beneficial effects of PVP; however, there are few reports on the risks associated with percutaneous vertebroplasty. The aim of the study was to evaluate the effects of treatment and complications of vertebroplasty on hundred and twenty vertebrae using polymethylmethacrylate cement (PMMA) focusing on the clinical manifestations and severity of PVP complications.

PATIENTS AND METHODS

A total of hundred and twenty PVPs in hundred individuals were performed at Suez Canal University Hospitals (Ismailia, Egypt) between 2010 and 2019.

Ethical Committee approval and written, informed consent were obtained from all participants.

All the patients met the following criteria: the vertebra was compressed by more than 50%, the posterior walls and pedicle of vertebral bodies were intact without neural compressive signs and decompression was not needed. There were seventy females (70%) and thirty males (30%), ranging in age from 24 to 74 years, with a mean age of 58 years.

Sixty patients had osteoporotic fractures, forty-five of which were single level fractures, and fifteen of which were two to three level fractures. Thirty patients had malignant disease, including five cases of myeloma, five cases of prostate carcinoma, fifteen cases of breast cancer, and five cases of lung cancer metastases. Two patients had painful vertebral hemangiomas, and eight others suffered from severe post traumatic fractures. From a total of hundred patients with painful fractures, eighty-five patients had a single fracture, and fifteen subjects had two or more fractures. **Table 1** shows the cause and the number of fractures. All the patients were admitted to the hospital because they were in excruciating pain or were experiencing an exacerbation of chronic pain. Patients were admitted after undergoing a computerized tomography (CT) or magnetic resonance imaging (MRI) within the previous two weeks. Up to six weeks from the onset of discomfort, all single fractures were identified as acute. In numerous fractures, the first level with a hyperintense signal within the bone marrow in a T2-weighted sequence with fat suppression was defined as a new fracture, while the rest were classified as chronic.

We discovered a two-year history of documented fractures in twelve out of the fifteen individuals with multiple fractures. All these patients had been treated conservatively previously, and they all complained of persistent discomfort that had worsened in the latest weeks before PVP. From two to six weeks prior to augmentation, all patients had severe pain. There were eighty osteoporotic fractures treated out of hundred and twenty surgeries, and thirty malignant disease-related fractures. In traumatic fractures, eight PVP were done. Solitary painful vertebral hemangiomas were seen in two cases. Seventy-five lesions (62.5%) were found in the thoracic region, whereas forty-five subjects (37.5%) were found in the lumbar region. The fractures were all compression fractures. **(Table 1).**

Table 1: The cause of PVP and number of affected vertebrae (number of fractures/number of patients)

Cause of Fractures	Single level	Multiple levels	Total
Osteoporosis	45/45	35/15	80/60
Neoplastic disease	30/30	-	30/30
Trauma	8/8	-	8/8
Vertebral hemangioma	2/2	-	2/2
Total	85/85	35/15	120/100

N.B: Due to doing PVP in multiple levels in the same subject. The number of fractures levels involved in the study is more than the number of involved subjects.

PVP: Percutaneous vertebroplasty.

Surgical technique

Patients were lying on a radiolucent surgery table in a prone position. Under the guidance of a C-arm image intensifier, the location of the pedicle of the vertebral arch was used to determine the needling spot. Routine sterile techniques were used to prepare and drape the skin.

The surgery was carried out under local or general anesthesia. In all patients, vertebroplasty was performed with a 13-gauge needle and a bilateral transpedicular route. We never utilized liquid cement; instead, we injected medium viscosity cement. Under fluoroscopic guidance, polymethylmethacrylate (PMMP) was carefully injected. When the cement reached the posterior wall of the vertebral body, the injection was discontinued. As PMMP formed, the cannula was taken out three to five minutes later.

Observation parameters

The effectiveness of the treatment was evaluated using a hundred points visual analogue scale (VAS) twelve hours after surgery, seven days later, thirty days later, and then every six months for the next year. We simply looked at the level of pain in the vertebral column. Before the operation, the height of the vertebral body was measured. During the procedure, the cement volume, distribution, and leakage in the vertebral body were observed and documented. During and after the procedure, the patient's blood pressure, heart rate, and respiration rate were all monitored. Cement volume, distribution, leakage, and vertebral height were all measured using X-rays.

Statistical analysis

The data was analyzed using the statistical package for the social sciences (SPSS 10.0). P value < 0.05 was considered as statistically difference.

RESULTS

The injection volume of PMMA was 0.5 to 3 mL in the thoracic area and 1 to 4 mL in the lumbar area. Prior to surgery, all patients experienced considerable pain on a VAS scale between seventy and hundred, with a mean of 93. With a mean VAS of 35, 95 percent of patients reported significant pain alleviation twelve hours following surgery.

After a year, more than 90% of patients reported pain alleviation, and the VAS score had marginally altered to an average of nineteen. **(Fig. 1)** summarizes the treatment results based on VAS values. Five patients, one myeloma patient and four osteoporotic patients had new fractures, three of which were near to previously injected vertebrae. The procedures were done on all patients with new osteoporotic fractures, and the results of treatment were all satisfactory.

Two patients had modest pain improvement, with leakage of cement into surrounding tissues as in **(Fig. 2)**. Another three patients experienced no pain alleviation, all of them had intracanal leakage as in **(Fig. 3)**. The 30th day assessment found that two of the three patients with leaking into the spinal canal had significant pain relief, while the third patient's discomfort remained the same.

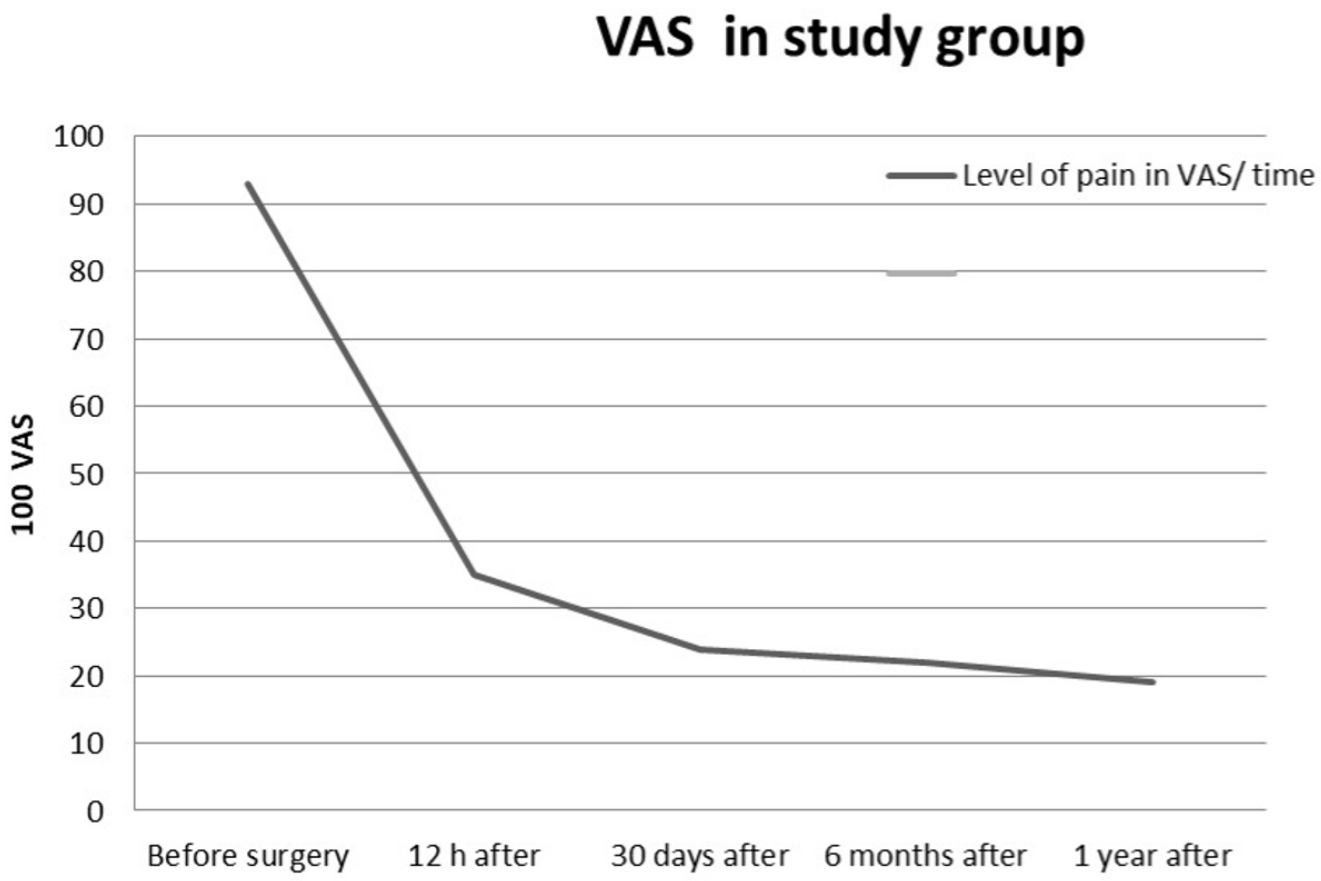

Fig 1: Results of treatment according to VAS values.

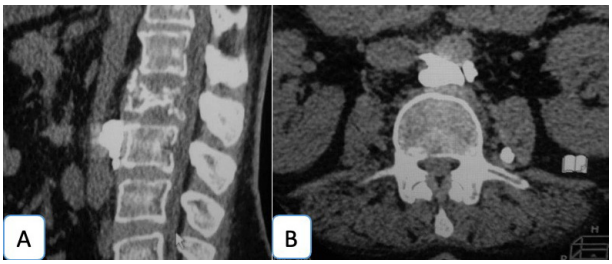

Fig 2: (A,B) Sagittal and axial CT lumbosacral spine of a 65 years old female with osteoporotic fracture L1. PVP was done with cement leak in front of the L2 vertebra below the fracture pushing the abdominal aorta. Clinically the patient improved and the cement leak was asymptomatic.

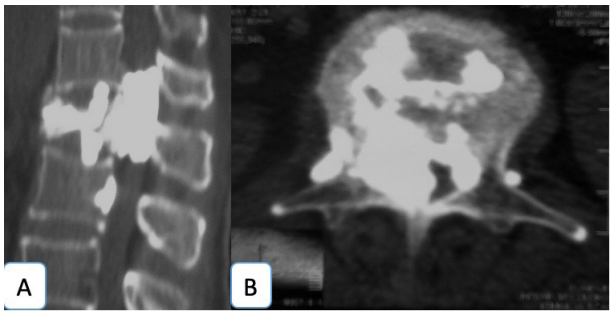

Fig 3: (A,B) Sagittal and axial CT lumbosacral spine of a 70 year old female with osteoporotic fracture L1. PVP was done with cement leak into the spinal canal with near complete occlusion. She developed paraparesis and required decompressive laminectomy. She showed gradual improvement in motor power after decompressive laminectomy and was able to walk after 6 months.

In forty-five augmented vertebrae, 37.5% of all surgeries, various complications were reported. Leakage was seen in 35% of osteoporotic fractures, 20% of neoplastic fractures, and 12.5% percent of traumatic fractures. We found paravertebral vein embolism in one patient with vertebral hemangiomas, but no additional complications. The most common PVP consequences in neoplastic and osteoporotic patients were leakage to surrounding tissue and paravertebral vein embolism. Intradiscal leakage was detected in 10% of individuals from all classes as in **(Fig. 4),** with no clinical signs.

Fig 4: X-ray thoracolumbar spine showing postoperative 3 level vertebroplasty with intradiscal cement leak of the upper level that was asymptomatic.

Intracanal leaking occurred in three individuals, one with a neoplastic condition and the other two with osteoporotic fractures. One patient with multiple myeloma experienced monoparesis of the lower extremities, whereas another developed paraparesis due to osteoporosis **(Fig. 3).** Decompressive laminectomy was required for both of them. After decompressive laminectomy, both of them demonstrated a steady improvement in motor function. After a 30-day evaluation, it was discovered that they had pain relief; however, in 14% of patients, there was evidence of leakage into the surrounding tissues. One case showed cement leak into the needle tract **(Fig. 5).**

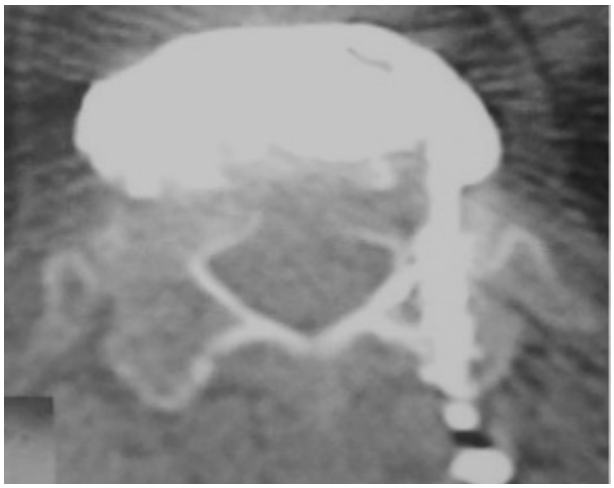

Fig 5: CT dorsal spine of a 60-year-old female with osteoporotic fracture D9. PVP was done with cement leak into the needle tract "needle cast" or "cement tail". She improved and the cement leak was asymptomatic.

There were no statistical differences between the thoracic and lumbar areas in terms of the incidence of complications. There were no variations between the ages and sex groups when it came to the number of complications. There were no statistically significant differences in treatment outcomes between patients who had augmentation complications and those who did not. Satisfactory to excellent pain relief was observed after vertebroplasty in more than 95% of patients.

DISCUSSION

PVP is a standard treatment for osteoporotic and malignant vertebral fractures, among a variety of other alternatives.[16] The actual mechanism of pain alleviation provided by vertebroplasty is unknown. Pain alleviation was thought to be secondary to thermal energy initially. In vivo, temperatures following vertebroplasty are not high enough to produce thermal necrosis of sensory nerves, according to new research. Alternatively, enhanced vertebral body strength and stiffness, as well as decreased mobility of the vertebral body and periosteal and interosseous nerves, are likely to provide pain alleviation after vertebroplasty. According to cadaveric studies, there is new bone growth after PVP.[17,18]

Despite some disagreement over the effectiveness of vertebroplasty, most studies show that treatment reduces

pain. Significant pain relief appears shortly after surgery and lasts for quite some time.[2,19] With time, the evidence for vertebroplasty in the treatment of osteoporotic fractures has grown.[20]

Technically, vertebroplasty with narrow-gauge needles is simple and safe to do. Despite the critics, treating fractures with cement injections gives immediate pain relief and improves quality of life. Because it is exceedingly unlikely that an elderly patient could also be cured by immobilization, delaying therapy is not recommended.[21]

When doing vertebroplasty, it is critical to pay close attention to anatomical structures.[16] PVP is usually safe, however it has been linked to serious clinical consequences, such as spinal cord compression,[5,6] or systemic embolism,[11,14,22] as well as less serious issues, such as infection or radicular pain.[8,23] Temporary pains following the treatment, as well as cement leaking into the intervertebral disc area and paravertebral soft tissues, are minor risks.[16]

Infection and cement leak into the epidural area are examples of moderate consequences.[16] Local PMMA leakage is common, affecting up to 90% of patients, however it usually causes no symptoms. Leaks into the paravertebral veins can cause pulmonary embolism, cerebral embolism, or heart perforation, among other serious problems.[11,12] Because of the possibility of damage of the vertebral body cortex and increased vascularization, leakage is more common in the treatment of malignant lesions.[3,24]

Infections, epidural hemorrhage, fat embolisms, cardiac injury, or arterial or renal embolism are among the consequences of PVP, according to literature.[8-15] These complications are quite uncommon, and we have not seen any in our experience. The amount of PMMA needed for the treatment can be kept to a minimum. Small quantities of PMMA can greatly relieve pain and help to prevent a variety of PVP complications.

PVP is a minimally invasive procedure; nonetheless, the incidence of problems, particularly extra-vertebral PMMA leaking, is high (up to 70%).[2,19,22] Complications were found in 37.5% of all surgeries done in our study, on the other hand, 97.5% showed no clinical signs. There was no difference in pain relief between those who had leaks and those who did not have any complications. Most of the patients' cement leakage was minor and did not necessitate further treatment. Leakage into the spinal canal was the only exception. It happened in three out of 100 patients, and in two of them, it resulted in serious consequences such as monoparesis and paraparesis, as well as widespread sensory problems. Five patients suffered new fractures throughout the one-year follow-up period. This opposes the theory that PVP causes additional compression fractures in neighboring vertebrae.[25]

CONCLUSION

Vertebroplasty is a minimally invasive surgical procedure with a low risk of complications. In more than 95% of patients, vertebroplasty effectively decreases pain. Nearly 40% of patients experience local problems. However, in over 90% of these problems, there was no effect on treatment outcomes.

List of abbreviations

CT: Computerized tomography. MRI: Magnetic resonance imaging.
PMMA: Polymethylmethacrylate cement.
PVP: Percutaneous vertebroplasty.
SPSS: Statistical packages for social sciences.
VAS: Visual analogue scale.

Disclosure

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