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Original Article

Transpedicular Percutaneous Vertebroplasty in Management of Osteoporotic Vertebral Compression Fractures Assessment of Clinical Outcome: A Study of 21 Procedures

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Abstract

Introduction: Osteoporotic vertebral fractures that produce increased morbidity, persistent back pain, risk of collapse with time, and increased fracture risk. Subsequently, these vertebral fractures produce kyphotic deformity and effect on lung capacity. In our study purpose is to assess the clinical outcome, safety, and efficacy of transpedicular percutaneous vertebroplasty in osteoporotic vertebral compression fractures (VCFs).

Methodology: The study done between December 2017 and December 2019 at our institute. A total of 10 patients with 21 vertebral body collapse in that 13 dorsal vertebra and 8 lumbar vertebral body included in the study in neurologically intact individuals. Patients are considered for treatment, those with chronic pain refractory to medical therapy and bracing and those with severe disabling pain caused by fractures. Severe cardiopulmonary disease, coagulopathy, and cord compression are contraindications to vertebroplasty. Severe vertebral compression may also be a contraindication to treatment, because the vertebra may be compressed to such a degree that needle placement and cement injection become impossible. After treatment, they selected one of three possible responses for each: Significantly improved, worse, or approximately the same. As an overall assessment analgesic requirement, visual analog scale, grading of subjective satisfaction score, sleep, and ambulation improvement assessed. To ensure uniformity despite the variable follow-up period, patients were instructed to indicate their status at 2 weeks after the procedure, 6 months, and 1-year follow-up.

Results: Both pain and functional outcome improved significantly in immediate post-procedure at 2 weeks, 6 months, and 1 year. The majority (70%) of the patients were treated for 2 levels while 2 patients were treated for 3 levels and 1 patient was treated for 1 level. Visual analog scale (VAS) in the pre-procedure period is 8.3 which decrease in the post-procedure period at 2 weeks and 6 months is 2.6 and 3.6 subsequently and at 1-year average VAS score is 4. Mobility and sleep pattern is significantly improved in 8 patients (80%) at 1-year follow-up whereas remain same in 2 patients.

Conclusion: Significant relief in pain in the post-procedure period with minimum risk noticed for VCFs.

Key words: Bone cement, Osteoporosis, Pain, Polymethylmethacrylate, Spine, Transpedicular vertebroplasty, VAS score, Vertebral compression fracture, Vertebroplasty

INTRODUCTION

Vertebroplasty originally used for an open surgical procedure that introduces bone graft or acrylic cement to mechanically augment weakened vertebral bodies. Polymethylmethacrylate (PMMA) is the acrylic most commonly used as a bone filler, and its application in the treatment vertebral compression fractures (VCFs) has been reported extensively.[1] First, image-guided percutaneous vertebroplasty done in France in 1984, when Galibert *et al.*[2] injected PMMA into a C2 vertebra that partially destroyed by an aggressive hemangioma. The procedure relieved the patient's long-term pain. After that, percutaneous vertebroplasty was used to treat VCFs caused by osteoporosis.[3]

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METHODOLOGY

All patients undergoing percutaneous vertebroplasty at our institution between December 2017 and December 2019. All patients underwent various combinations of plain X-rays and magnetic resonance (MR) imaging to assess the fracture pattern and to exclude other causes of pain such as herniated intervertebral disc, facet arthropathy, spinal stenosis, aggressive hemangioma, myeloma, and osteolytic metastasis.

Before initiating percutaneous vertebroplasty, careful assessment and evaluation of the patient needed to ensure that the pain is related to VCF. Compression fracture pain usually worsens with weight bearing and improves with recumbency, pain is typically localized to the area of the fracture and lacks radicular qualities that suggest nerve root or cord compression. Local palpation over the posterior elements of the involved vertebral body will often elicit pain. Patients were excluded if the affected level was completely free of pain on palpation, if there was an overwhelming radicular component to the pain, or if the fracture seemed too compressed to permit percutaneous access and cement delivery. Patients with severe spinal canal compromise were also excluded from the study. Patients are considered for treatment, those with chronic pain refractory to medical therapy and bracing and those with severe disabling pain caused by fractures. Severe cardiopulmonary disease, coagulopathy, and cord compression are contraindications to vertebroplasty. Severe vertebral compression may also be a contraindication to treatment, because the vertebra may be compressed to such a degree that needle placement and cement injection become impossible. An absolute degree of vertebral compression that precludes treatment cannot be defined. An upper thoracic vertebra compressed by 50% may be impossible to treat safely, yet a lumbar vertebra compressed by 75% may still be treated because the remaining height is significant.

Clinical examination and plain X-ray are used to confirm the compression level with MR imaging done. MR images show both anatomic vertebral collapse and loss of normal signal from the marrow space of vertebrae with acute fractures. These findings are well appreciated on sagittal T1-weighted sequences because the edema associated with the compression produces a low (dark) signal intensity compared with the high (bright) signal normally seen in the marrowfat. Heavily T2-weighted sequences, such as sagittal short-tau inversion recovery sequences, are the most sensitive, with fluid representing marrow edema.[4]

High-quality fluoroscopic equipment is essential for the safe performance of vertebroplasty. The cannula must be placed accurately to avoid collateral damage, and the cement must be observed during injection to prevent extravasation. Fluoroscopic images taken in both plane with c arm equipment allows the procedure to be performed more rapidly.

Patients typically receive intravenous antibiotics 30 min before the start of the procedure. Prophylactic pre-operative antibiotics (typically 1 g of cefazolin 30 min before the procedure) are routinely administered to the patient. Antibiotics may also be administered in the cement. Such delivery is usually used for patients who are known to be immunocompromised. The level at procedure planned is prepared in a strictly sterile manner, with sterile drapes used over other regions. All personnel in the procedure room must observe a full sterile protocol. Proper fluoroscopic projection that places the pedicle of the vertebra over the vertebral body is chosen and local anesthetic is injected into the overlying skin, needle tract, and periosteum of the involved bone. A small incision is made with a scalpel. Using fluoroscopic guidance, an 11-gauge bone biopsy needle consisting of an access cannula with a beveled trocar is inserted through the skin and seated against the periosteum. Under biplane fluoroscopic guidance, the needle is advanced through the midportion of the pedicle and into the cancellous interior of the collapsed vertebral body. The entry site near the mammillary process and the angulation of the needle trajectory are slightly different from those used for pedicle screw placement. Initially, the needle, the contour of the pedicle, and the central X-ray beam are all positioned along the same axis, thus allowing the needle to be directed concentrically. Within the pedicle, the bevel of the needle is oriented so that the tip points laterally, avoiding the spinal canal.[5] Once within the vertebral body, however, the bevel is rotated to direct the needle tip toward the midline, which usually obviates the need for bipedicular access [Figures 1-3]. Similar rotations of the bevel can direct the needle away from the superior and inferior endplates. The needle should ultimately reach the anterior third of the vertebral body. The position is checked in both anteroposterior and lateral projections. The trocar is removed and transosseous venography is performed by injecting nonionic contrast material through the cannula. If rapid, brisk filling of either the perimedullary veins or the inferior vena cava is observed, anastomotic channels of the basivertebral venous plexus may be embolized with a slurry of microfibrillar collagen, saline, and contrast medium. This strategy minimizes the risk of pulmonary embolism or epidural compression when cement is subsequently injected into the vertebral body venography may also help evaluate the filling pattern and identify potential sites of PMMA leakage outside the vertebral body.[3] Such information may prompt repositioning of the needle by advancement, withdrawal,

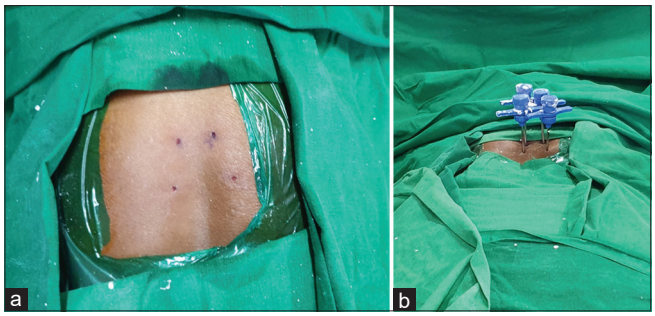

Figure 1: (a and b) Application of trocar needle after confirmation of collapse levels

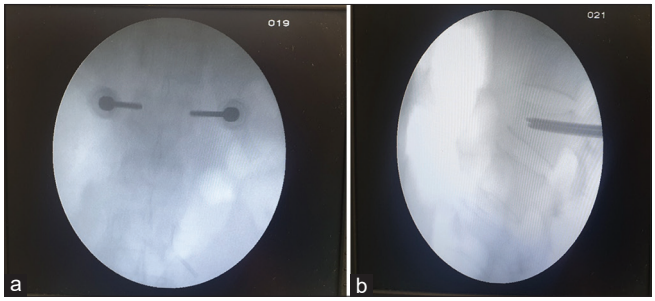

Figure 2: Anteroposterior (a) and lateral (b) fluoroscopic images after needle placement. The needles have been staggered by alternating between the right and left pedicles at contiguous levels (a). The needle tips have been placed near the midline (A) and in the anterior third of the vertebral body (b)

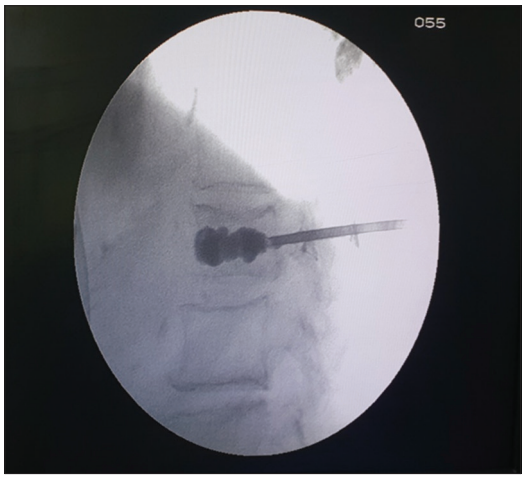

Figure 3: Fluoroscopic images of the thoracolumbar junction after injection of polymethylmethacrylate ideally, the cement permeates the anterior three-fourths of the vertebral body and at least two-thirds of its transverse dimension

or rotation. The optimum period for injection is generally between 5 and 15 min after combination when a semifluid texture similar to toothpaste is achieved. Insufficient polymerization of the acrylic cement at the time of injection may be one factor that contributes to migration into the vena cava and subsequent pulmonary embolism.[6,7] Conversely, by the time the mixture begins to heat up from the exothermic polymerization reaction, it is usually too viscous to deliver. Under continuous fluoroscopic monitoring, PMMA is injected into the interstices of the vertebral body.

Once the procedure is completed, the patient should be maintained recumbent for the next 2 h to prevent weight bearing and axial loading while the cement hardens. PMMA cements typically set within 20 min and achieve approximately 90% of their ultimate strength within 1 h of injection.[8] Antibiotic ointment should be applied to the needle introduction sites and then covered with a sterile bandage. The patient is made ambulatory overnight and is discharged 24 h later from the hospital following clinical and radiological assessment.

Our outcomes assessment had to be kept as simple as possible. Assessment of visual analog scale between 1 and 10 (1 is totally relived and 10 is same or worse pain), subjective satisfaction scale between 1 and 5 (1=worse, 2=same, 3=good, 4=very good, 5=excellent). Functional impact of pain on patients' lives to compare their ambulatory status, the ability to sleep comfortably, and analgesic/narcotic requirements before and after treatment.

After treatment, they selected one of three possible responses for each: Significantly improved, worse, or approximately the same. To ensure uniformity despite the variable follow-up period, patients were instructed to indicate their status at 2 weeks, 6 months, and 1 year after the procedure.

RESULTS

The procedure was performed in 10 patients involving 21 vertebrae (lower thoracic – 13 and lumbar – 8). Most patients were of the elderly age group with mean age of 64 years (range 50–70 years). All the patients presented with severe intractable pain with varying degree of impaired mobility of relatively longer duration. The procedure was successful in 10 patients. In 1 patient, it was extravasation of dye and bone cement in epidural space in the post-operative period for that open decompression with removal of bone cement from epidural space and surgical stabilization done. The bilateral transpedicular approach was done in all patients.

The majority (70%) of the patients were treated for 2 levels while 2 patients were treated for 3 levels and 1 patient was treated for 1 level. The amount of bone cement injected per vertebral body varied from 2 ml to 8 ml with an average of 5 ml.

The clinical response to the procedure was assessed immediately after the procedure, 2 weeks, 6 months, and

1 year period. The visual analog scale (1–10), grading of subjective satisfaction (1–5), analgesic requirement, ambulation after procedure, improvement in sleep were monitored. Average visual analog scale (VAS) in the pre-procedure period is 8.3 which decrease in the post-procedure period at 2 weeks and 6 months is 2.6 and 3.6 subsequently and at 1-year average VAS score is 4. Mobility and sleep pattern is significantly improved in 8 patients (80%) at 1-year follow-up whereas remain same in 2 patients. Average subjective satisfaction score at 6 month period is 3.8 and at 1 year of follow up period average score is 3.1. No recurrence of pain and further vertebral collapse was seen during a mean follow-up of 1 year.

DISCUSSION

Acute complications of a vertebral fracture include transient ileus, urinary retention, and the hazards of protracted immobilization, while long-term effects include kyphosis, deconditioning, insomnia, and depression.[9,10] Patients with osteoporotic compression fractures have significantly higher mortality rates than age-matched controls and are more than twice as likely to die from pulmonary causes.[11] Vital capacity, forced expiratory volume, and other measures of pulmonary function are significantly diminished in patients with spinal compression fractures as compared with those with back pain from other causes. In one model, each thoracic compression fracture reduced forced vital capacity by more than 9%.[12]

While bed rest, bracing, and analgesic medication remain the mainstay of therapy, refractory pain and debility complicate a significant percentage of compression fractures.[13] Surgical intervention is uncommon due to the technical impediments imposed by osteopenic bone and the high prevalence of comorbid conditions in this patient population. Percutaneous vertebroplasty, the injection of PMMA bone cement into the collapsed vertebral body, has emerged as an accepted form of therapy for osteoporotic compression fracture.[14] An injection of PMMA mechanically reinforces the vertebral body and may reduce pain by halting further compression, deformity, or micromotion.[15] Alternatively, it has been proposed that the heat generated by the exothermic polymerization of PMMA damages pain-sensitive nerve endings within the vertebra and surrounding tissues.[14]

One of the principal determinants of outcome is proper patient selection. The ideal candidate for percutaneous transhepatic portal venography (PTPV) presents within 4 months of the fracture and has midline, nonradiating axial pain that increases with weight bearing and is exacerbated by manual palpation of the spinous process at that level up to two-thirds of osteoporotic compression fractures never comes to the attention of the clinician.[16] Since some patients have associated fractures that are incidental, it is crucial to identify the symptomatic level requiring treatment. Exclusion criteria include collapse to <20% of the original height (vertebra plana) and other fracture patterns that preclude safe access to the vertebral body. With technical modifications, however, some have documented the feasibility of treating fractures collapsed more than 80%.[17] Patients with active infections of the spine or coagulopathy should not undergo vertebroplasty. One limitation of this procedure is that the outcome is not easy to evaluate. Outcomes are subjective, and in placebo effects cannot be excluded from the study. The study population included many elderly patients with memory deficits and others who are inherently difficult to question. Several patients developed new compression fractures during the course of follow-up, which made it a difficult assessment.

Extrusion of PMMA was common, especially when the fracture plane extended to the endplates or cortical surfaces. Extrusion may occur into the epidural space of the spinal canal, the neural foramen, the intervertebral disc space, or the paraspinal veins and lungs. Each pattern of extrusion carries distinct risks. Extrusion of bone cement is complication most commonly seen, in our study one patient after Percuteneous transpedicular vertebroplasty (PTPV) show bone cement exctrusion in inferior disc space, who ultimately improved after undergoing surgical removal and stabilisation of extruded intradiscal bone cement.

CONCLUSION

Tranpedicular percuteneous vertebroplasty provide significant pain relief related to osteoporotic vertebral compression fractures and decrease period of morbidity with a very low complication rate.

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