6a

PERCUTANEOUS VERTEBROPLASTY

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1. Introduction:

Percutaneous vertebroplasty is a popular and emerging minimally invasive technique. Polymethyl methacrylate (PMMA) is injected into the vertebral body under radiological guidance to maintain the stability and strength of the spinal column and to decrease patient pain. Galibert *et al.* [1] reported the first case in a patient with a painful vertebral hemangioma in 1987. In recent years, the indication was widened to include other painful osteolytic lesions of the vertebral body [2]. Approximately, 700,000 people have vertebral body fractures secondary to osteoporosis, and this results in a decrease in patient quality of life [3]. Today, vertebroplasty is used generally for two primary indications: the treatment of metastatic vertebra tumours and symptomatic osteoporotic vertebra compresion fractures (VCF).

2. Indications:

The suitable patient selection is very critical for obtaining good clinical results. Although the indications of vertebroplasty have widened in the recent years, the primary indications are noted here:

1. The most suitable cases for vertebroplasty are painful osteoporotic vertebral fractures which are not clinically improved after 4-6 weeks of conservative management (external bracing, analgesics, narcotic agent).
2. Vertebroplasty can be performed for aggressive and symptomatic vertebral body hemangiomas which lead to fracture of the body, metastatic tumours, vertebra osteonecrosis, osteogenesis imperfecta and acute vertebral body fractures.
3. Vertebroplasty can be performed for the treatment of chronic, traumatic vertebral fractures which are not fused following trauma.
4. Vertebroplasty can be chosen to decrease the symptoms of vertebral tumors which are multifocal and inoperable.

3. Contraindications:

Appreciation of the contraindications of vertebroplasty and important in avoiding complications. Generally, the main contraindications of vertebroplasty are noted below:

1. Unstable fractures of the vertebra, retropulsation of the fractured fragment into the spinal canal with compression of the cord or nerve root, and loss of vertebral body height more than 70%.
2. Allergic allergy to the vertebroplasty cement
3. Low technical capacity with the radiological tools used in the procedure and difficulties with detection of the landmarks of the operation.
4. Systemic and/or local infections, known difficulties with general and/or local anesthesia, and bleeding and coagulation disorders.
5. Asymptomatic VCF and prophylactic management of osteoporotic fractures at other levels.

4. Surgical Procedures

4.a. Surgical Equipment

The standard sterilization equipment for spinal surgery such as betadine, alcohol solution, drape and sterile towels are prepared. After the sterilization equipment is prepared, uniquely sized 22-25 gauge

spinal pins and 11-13 gauge bone biopsy pins are prepared. Additionally, PMMA cement, sterile barium sulfate, screw-down injector reservoir syringes are also prepared prior to initiation of the operation (Figure 1a, b).

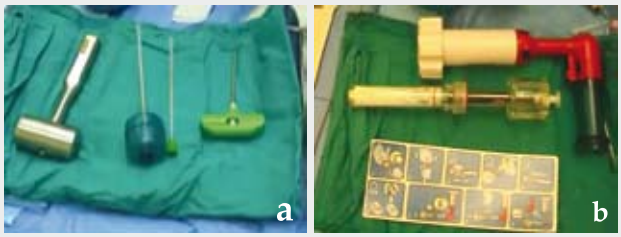

Figure 1a,b:
The general operating equipment is seen.

4.b. Operating room set up

A proper operation table for standard spinal surgery is prepared and high quality single and/or biplanar fluoroscopy unit is positioned according to the choice of the surgeon. The monitors used for the fluoroscopy unit and surgical tools are localized just opposite to the surgeon to obtain the views of anatomical landmarks during the percutaneous procedure. This should be established prior to beginning the operation (Figure 2).

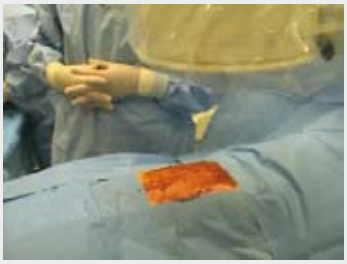

Figure 2:
The patient positioning and AP setting of the fluoroscopy is seen.

4.c. Patient positioning:

The patient placed on the operating room table in the prone position. Then, prone and semi-flexion position is chosen for the patient and the body is supported with silicon pillows for the vertebroplasty procedure of the thoracal and lumbar vertebrae. Both arms are located above the shoulders at flexion position to enable the use of lateral fluoroscopy scans.

4.d. Surgical Technique:

The percutaneous transpedicular vertebroplasty can be performed under general anesthesia, local anesthesia, or conscious sedation. After the placement of the patient in the prone position, antero-posterior and lateral fluoroscopic images of the affected vertebral body and pedicle are taken (Figure 3a). The lateral projection of the pedicle is localized with a Jamshidi needle under AP fluoroscopy and a 1 cm skin incision is made. After the incision, the upper and lateral wall of the pedicle is targeted and the Jamshidi needle is inserted through the muscle (Figure 3b). It optimal to have the Jamshidi needle is closer to the medial wall of the pedicle as one guides down the length of the pedicle during cannulation. The cranio-caudal position of the Jamshidi needle inside the pedicle is also monitored closely with lateral fluoroscopy. If the vertebroplasty procedure is to be bilateral, the same procedure is performed to the opposite side (Figure 3c, 3d). Frequent fluoroscopy control is critical for safe placement and guidance of the needle. (Figure 3e, 3f). The Jamshidi needle is stopped at the anterior wall of the vertebral body. The anterior wall of the body should remain intact during the entire procedure. The thorocar is stabilized and positioned at the anterior wall and a canal is maintained within the body with a hand drill.

The bone cement PMMA is prepared and put inside the syringe of the system and maintained until a "toothpaste-like" consistency (Figure 4a). Then, a connection established between the system and the trocar (Figure 4b, 4c). After this process, the cement is inserted into the vertebral body using a volume of 0.5 ml under low pressure with continuous AP and lateral fluoroscopy control. The processes is continued until the cement reaches the posterior one-third of the vertebral body (Figure 4d). The same procedure can be completed on the opposite side, as shown (Figure 4e, 4f). The process is then done at this time. We believe that the use of 2-4 cc of cement for thoracic and 4-6 cc cement for the lumbar spine is adequate for maintaining the strength adn stability of the veretebral body and to improve clinical pain [4]. The system is removed after the bone cement has solidified and the skin is closed [5,6]. The vertebroplasty must be stopped if the cement extends to the anterior or posterior portion of the vertebra body.

The transpedicular approach is the gold standard for percutaneous vertebroplasty. However, an extrapedicular approach is chosen for the higher thoracal spine and inadequately sized pedicles. The cranio-lateral point of the pedicule is the ideal insertion point for the extrapedicular approach. Additionally, fluoroscopy and computed tomography may be essential at the upper thorasic vertebra (Th1-4) because of the shoulder joints [7]. Although the unipedicular approach is adequate, the bilateral approach can be performed for vertebroplasty.

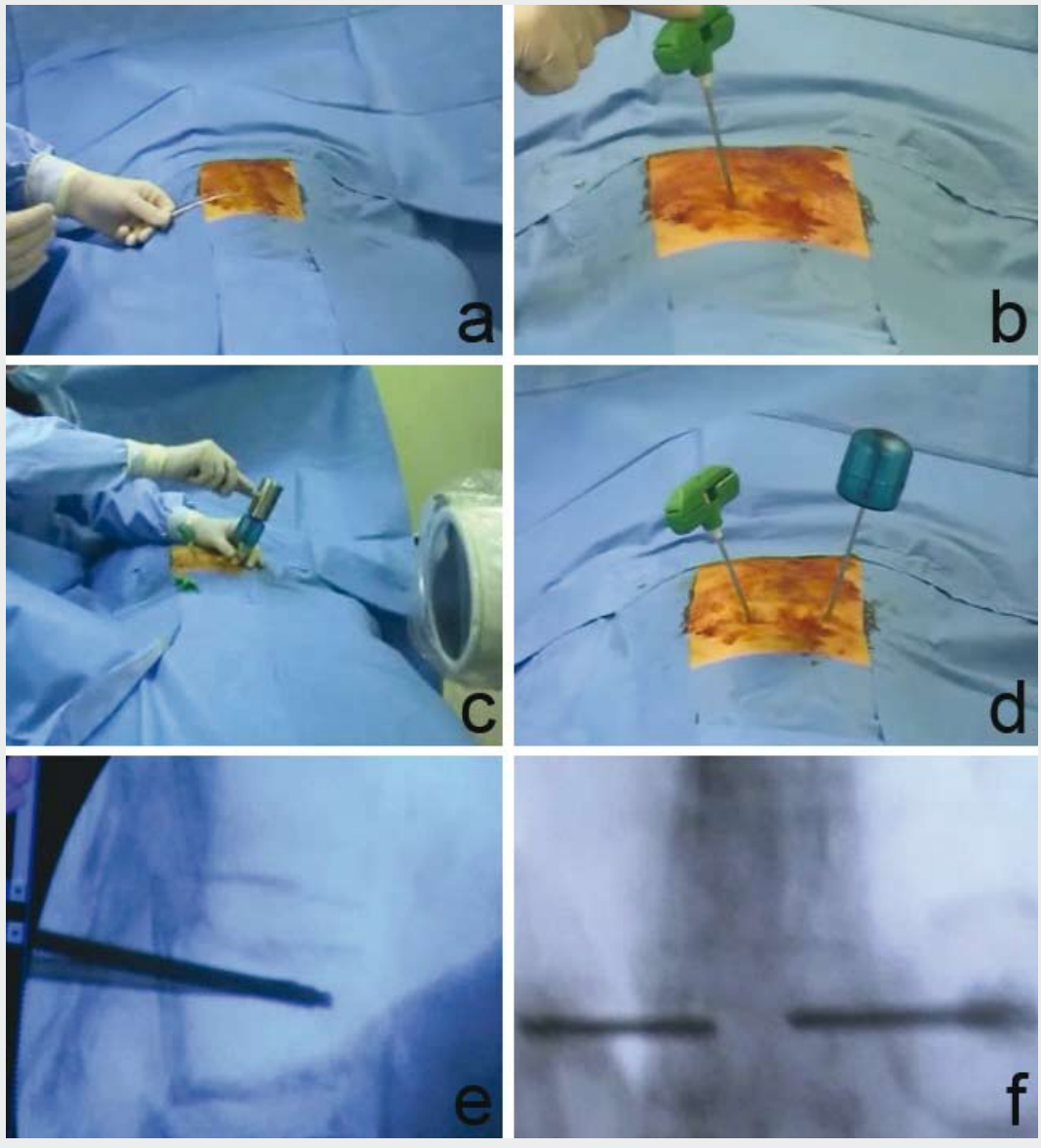

Figure 3:
a) Targetting the upper and lateral wall of the pedicle antero-posterior fluoroscopic images **b)** Jamshidi needle is inserted through the muscle, targetting the upper and lateral wall of the pedicle **c,d)** Same procedure is performed to the opposite side nad cranio-caudal position of Jamshidi needle is controlled under lateral fluoroscopy **e,f)** AP and lateral fluoroscopic images of the Jamshidi needle is shown.

Microsurgical interlaminar vertebroplasty can be performed in cases of neural tissue compression (lumbar disc hernia, ligamentum flavum hypertrophy, lumbar stenosis, etc.) at the level of the compression fracture. The laminae, ligamentum flavum and the medial facet are excised by this process to decompress the thecal sac and segmental nerve root. The vertebroplasty canule is inserted into the vertebra body lateral to the thecal sac and cement is injected after the insertion of trocar under lateral fluoroscopy [8].

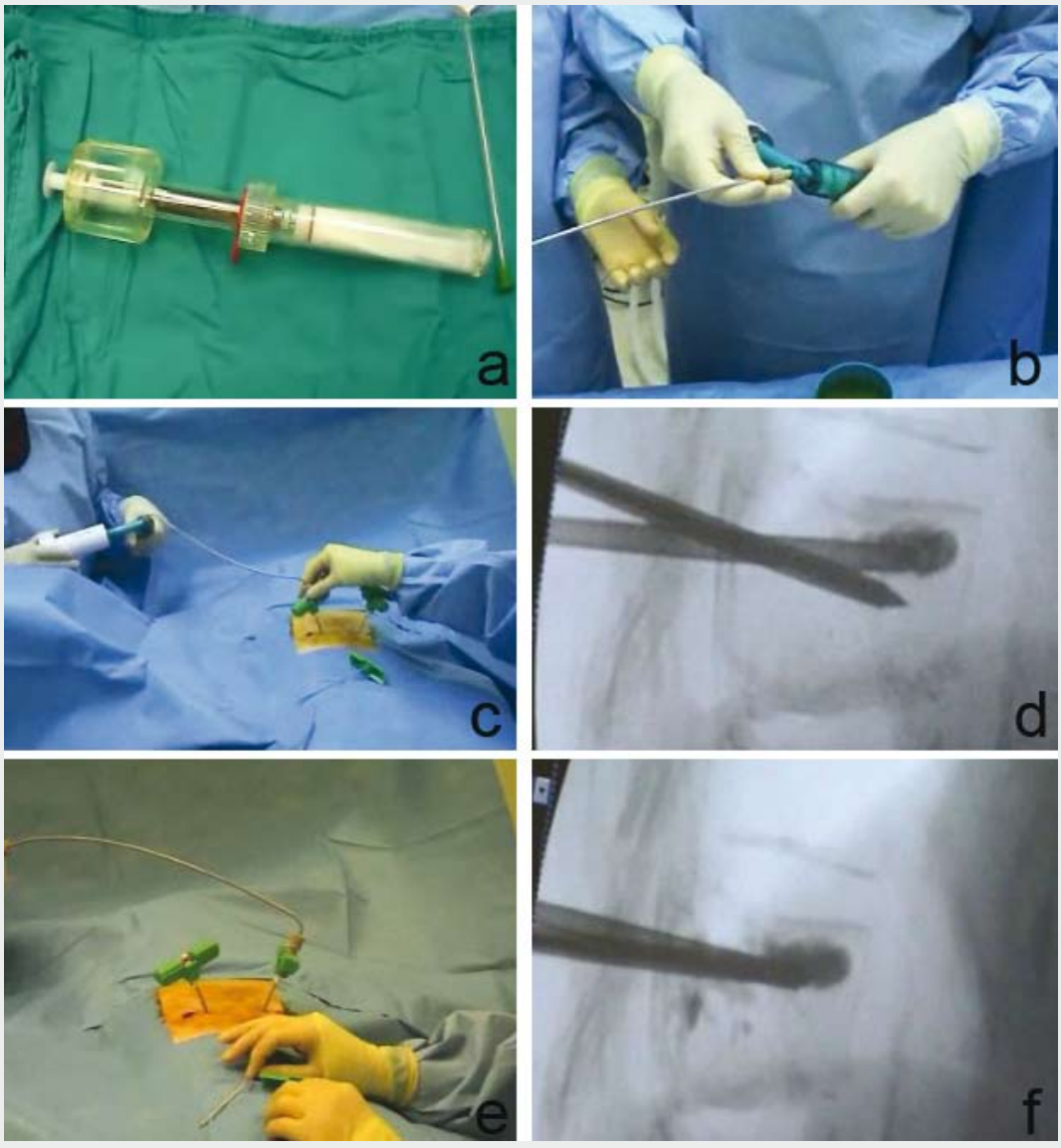

Figure 4:
a) The prepared bone cement PMMA put inside the syringe of system **b,c)** Connection is done between system and thorocar and cement is inserted into the vertebral corpus **d)** lateral fluoroscopic images of the bone cement insertion **e,f)** opposite side bone cement insertion and its lateral fluoroscopic images is shown.

5. Postoperative Care:

Neurological examination must be performed immediately after the operation. The patients are discharged after 2-3 hours of bed rest. We advise to use of a thorocolumbar corset for 1-2 weeks following the procedure.

6. Complications and Avoidance:

This percutaneous vertebroplasty procedure can be done with a low rate of complication in the hands of experienced surgeons [9]. However, rare complications include dural tears, root injuries, spinal cord injury, arterial injury, pneumothorax, haemothorax, rib, and fractures to the pedicle and adjacent vertebra can be seen during the procedure [10]. Spinal canal stenosis and/or spinal cord compression due to cement leakage through the posterior wall of vertebra corpus may cause neurological deficits. Leakage into the spinal neural foramen may cause nerve root compression and related complications. The heating capacity of the cement during the chemical solidification process also has been shown to potentially contribute to neural injury [9-11]. The cement leakage into the paraspinous venous structures adjacent to anterior wall of the vertebral body has also been shown to result in pulmonary and cerebral emboli. Other notable, but rare complications include infection and anaphlaxic reaction to the components of the cement [12,13].

We believe that the first, and most important step, to avoid complication is intensive education with cadavers and the development of surgeon understanding of the associated minimally invasive anatomy. Additionally, the surgeon must have exposure to surgeons who are experienced in the technique. Attention to preoperative patient preparation, equipment sterilization and proper patient selection may also help to decrease complications. Visualization of adequate cement opacification on fluoroscopy may also help the surgeon to detect the landmarks of surgery and decrease the complications.

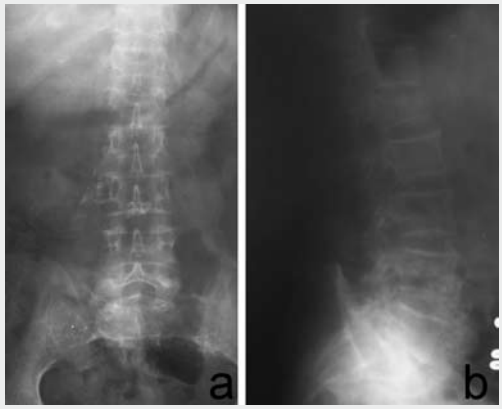

Figure 5a, 5b:
The pre-operative AP and lateral X-ray graphies of L1 osteoporotic vertebra fracture is seen.

Figure 5c, 5d:
The post-vertebroplasty AP and lateral X-ray graphies of L1 osteoporotic vertebra fracture is seen.

7. Case illustrations:

Case 1:

A 60 year-old female patient was admitted to the neurosurgery department with complaints of back pain and difficulty with walking after a fall down her stairs one month ago. The patient's neurological exam was normal, however she had severe difficulty with

walking because of severe back pain. The thorocal and lumbar direct radiographs revealed a L1 vertebra compression fracture and associated kyphosis (Figure 5a, 5b). There was no compression of the thecal sack when evaluated by lumbar CT and MRI and the posterior wall of the vertebra body was intact. The bone density of the patient revealed osteoporosis (T-Score: -3,4). Percutaneous vertebroplasty was performed for the L1 vertebral body under general anesthesia and fluoroscopy (Figure 5c, 5d). The patient was mobilized the same day of the operation and discharged on post-operative day #1. The patient continued to do well at last follow-up (12 months) at which point her pain continued to be improved.

8. References:

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