Percutaneous balloon kyphoplasty, a good minimally invasive surgical option for osteoporotic thoracolumbar compression fracture

Md. Anowarul Islam, Manish Shrestha, Santosh Batajoo, Dipendra Mishra and Khandaker Hafijur Rahman

Article Info

Spinal Surgery Unit, Department of Orthopedic Surgery, Faculty of Surgery, Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka, Bangladesh

For Correspondence:
Md. Anowarul Islam
maislam.spine@gmail.com

Received: 10 May 2018
Accepted: 23 May 2018
Available Online: 30 May 2018

ISSN: 2224-7750 (Online)
2074-2908 (Print)

DOI: 10.3329/bsmmuj.v11i2.36627

Keywords: Balloon kyphoplasty; Fracture; Osteoporosis; Thoracolumbar compression

Cite this article:
Islam MA, Shrestha M, Batajoo S, Mishra D, Rahman KH. Percutaneous balloon kyphoplasty, a good minimally invasive surgical option for osteoporotic thoracolumbar compression fracture. Bangabandhu Sheikh Mujib Med Univ J. 2018; 11: 199-202.

Available at:
www.banglajol.info

A Journal of Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

Abstract

The aim of this study is to evaluate balloon kyphoplasty as a surgical option for osteoporotic thoracolumbar compression fracture. The study was conducted on 30 patients from January 2014 to December 2017. The anterior vertebral height, kyphotic angle and functional evaluation by Oswestry disability index (ODI) and visual analogue scale (VAS) score were recorded preoperatively, immediate post-operatively at 3, 6, 12 months and yearly then on. All patients showed improvement in mean kyphotic angle from 16.4 ± 3.5 to 5.6 ± 1.7 post-operatively and 8.4 ± 1.6 at final follow-up. There was significant increase in mean anterior vertebral height from 51 ± 7.3% before surgery to 75.5 ± 7.4% at one day after surgery and 71.2 ± 3.2% at the last follow-up. There was significant improvement in mean VAS score from 8.1 ± 0.9 before surgery to 2.2 ± 0.4 at one day, and 2.4 ± 0.3 at final follow-up. The improvement in patients' ODI score after surgery from 71.4 ± 3.4 to 26.0 ± 4.8 at one day and 21.2 ± 5.5 at final follow-up was noted. The mean operating time was 45.5 ± 15.5 min for each vertebra. Within first day of surgery improvement in pain relief and mobility was experienced by all patients. The orthopedic balloon ruptured in one patient and it was replaced then procedure was continued with no complications. There were no neurological complications in all cases and there was no infections and any occurrence of symptomatic pulmonary embolism. In conclusion, balloon kyphoplasty is a good minimally invasive procedure where along with reduction of pain and disability there is also restoration of sagittal alignment post-operatively.

Introduction

Osteoporosis is a systemic skeletal disease characterized by low bone density and micro-architectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture.[1] Vertebral compression fracture is the leading cause of morbidity and disability in the elderly.[2-4] Acute pain due to vertebral compression fracture may subside over period of weeks or months however it is not uncommon that chronic pain is seen in number of cases leading to significant disability.[5] Chronic pain may be due to incomplete healing with progressive vertebral collapse, spinal deformity leading to altered spinal kinematics or development of pseudoarthrosis at the involved level. This often leads to decreased quality of life and depression.[5, 6]

Shift of the center of gravity anteriorly due to kyphotic deformity puts more stress on apex of kyphosis promoting further angulation and additional fractures.[7-10] The kyphotic deformity is well associated with functional status, risk of further fracture,[11, 12] neurological manifestation, mental health, and pulmonary function,[13] which can contribute to increased mortality rate.[14, 15] The conservative treatment which includes analgesics, bed rest, corset or spinal brace and rehabilitation is the mainstay of treatment of vertebral compression fracture.[16, 17] However, with the advent of minimally invasive surgical technique including vertebraplasty and kyphoplasty, it provides quicker relief from pain and improvement in physical functional status compared to medical treatment. In addition, being less traumatic and less risk for elderly patients these are also considered good option than open procedures which is limited to cases with spinal instability and/or neurological deficit.[18, 19]

Considering limitation of medical treatment and furthermore immobilization leading to bone demineralization and muscle deconditioning[20] predisposes it to future fracture, two minimally invasive approaches balloon kyphoplasty and vertebroplasty were developed for management of symptomatic vertebral compression fracture.[21, 22]

The first description by Galibert et al. (1987),

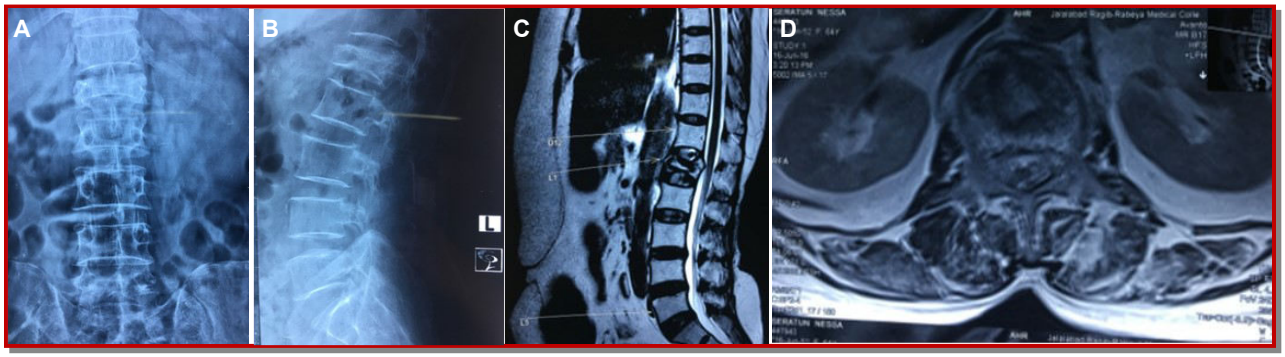

Figure 1: X-ray showing vertebral compression fracture at D11 AP (A) and lateral (B) view; MRI showing sagittal (C) and axial (D) view of vertebral compression fracture at D11

vertebroplasty involves percutaneous injection of polymethylmethaacrylate into the body of the vertebra.[23] In balloon kyphoplasty, with the use of a tamp (balloon) before injection of polymethylmethaacrylate using transpedicular or extrapedicular approach creates a cavity compressing cancellous bone and if possible religns the vertebral endplates. The purpose of this study was to evaluate the efficacy and safety of balloon kyphoplasty in the treatment of symptomatic vertebral compression fractures.

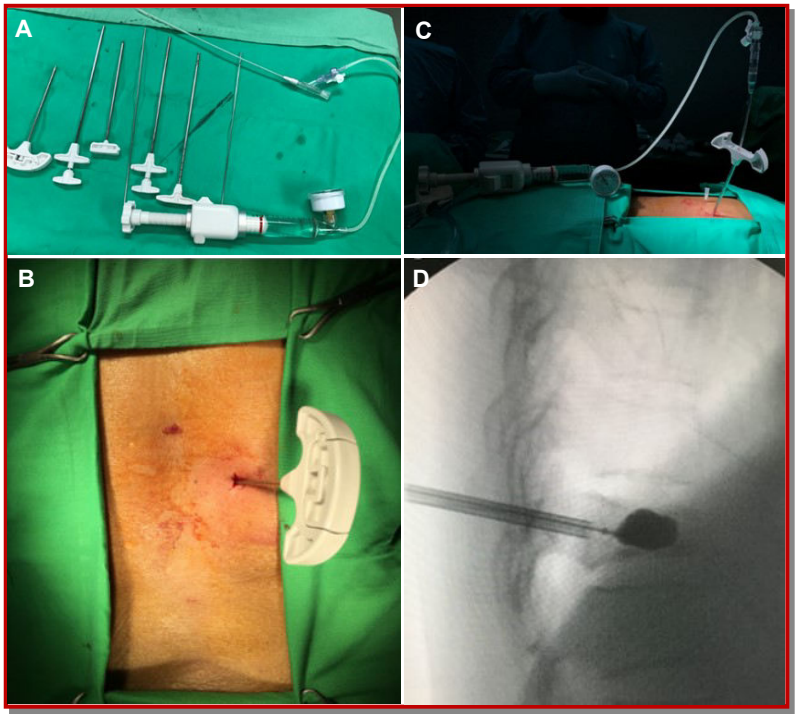

Figure 2: Balloon kyphoplasty set (A); Intraoperative picture with placement of cannula (B); Placement of cannula and micropressure instrument used for correction of kyphotic angle by inflation of balloon (C); Volume of the balloon was controlled with micropressure by the surgeon until reduction of the kyphotic angle or when the inflation pressure reaches 220 psi (D)

Materials and Methods

Thirty patients with symptomatic osteoporotic vertebral compression fractures between January 2014 to December 2017 who underwent balloon kyphoplasty in Bangabandhu Seikh Mujib Medical University and other private hospitals around Dhaka were included in the study. Active infection, neurological deficit, and uncorrected therapeutic anticoagulation were exclusion criteria for the surgical procedures. There were 8 males (26.7%) and 22 females (73.3%) with mean age of 72.5 years (range 60-85 years).

Surgical technique

Patient positioned prone and under general anesthesia. The proper positioning and bolster support improves chance of correcting kyphosis. Transpedicular approach is used for lumbar vertebrae and extrapedicular approach in thoracic spine as pedicle has smaller diameter and less medially angulated pedicle. In transpedicular approach trochar tip is introduced at the outer aspect of the pedicle under fluoroscopic guidance and passing through centre of the pedicle. At the posterior vertebral cortical margin it should be just within the medial border of the pedicle outline on PA view under c-arm. The trocar is then exchanged with cannula over a guidewire and working instrument is advanced 3 mm from the anterior border of the body of vertebra. In thoracic vertebra, the needle starting point is craniolateral towards the costovertebral joint and is advanced along the neck of the rib or transverse process. And lateral pedicle wall is reached and passed through upper and outer circumference of the pedicle. Only after posterior vertebral wall has been passed on lateral view should the needle tip cross the medial pedicle wall on PA view. Adherence to these landmarks is essential to avoid spinal perforation.[24, 25] A brief illustration with image is given in Figure 1 and Figure 2.

Cobb angle was measured from superior endplate

Table I

Showing mean value of preoperative, post-operative and final follow-up VAS, kyphotic angle, anterior vertebral height and ODI score

Mean	Pre-operative	Immediate post-operative	Final follow-up	p value
Visual analog scale	8.1	2.3	2.4	<0.05
Kyphotic angle	16.4	5.6	8.4	
Anterior vertebral height	51	75.5	71.2	
Oswestry disability index	71.5	26.0	16.4	

one level above the treated vertebrae to the inferior endplate of the lower vertebral body on the lateral radiograph and anterior vertebral height and any leakage of cement were also recorded. Oswestry disability index (ODI) was used to assess functional outcome and visual analog scale (VAS) for evaluation of pain. Follow-up was done at three month, six month and one year post-operatively and annually thereafter.

Statistical analysis

SPSS statistical software was used for analysis of data. Preoperative and postoperative measurements and values were compared using the paired t-test, with statistical significance was set at $p<0.05$.

Results

Radiological evaluation of all 30 patients treated showed mean kyphotic angle improvement from 16.4 ± 3.5 to 5.6 ±1.7 post-operatively and 8.4 ± 1.6 at last visit. The increment in mean anterior vertebral height was significant i.e., from 51 ± 7.3% before surgery to 75.5 ± 7.4% at one day after surgery and 71.2 ± 3.2% at the last follow-up. Significant improvement in mean VAS score from 8.1 ± 0.9 before surgery to 2.2 ± 0.4 at one day, and 2.4 ± 0.3 at final follow-up was observed. The patients' ODI score also improved after surgery, which was 71.4 ± 3.4 to 26.0 ± 4.8 at one day and 21.2 ± 5.5 at final follow-up. The improvement in VAS, kyphotic angle, anterior vertebral height, ODI score was statistically significant with $p<0.05$ with paired t-test which is shown in Table I. The mean operating time was 45.5 ± 15.5 min per level. Within first day after surgery patient experienced some pain relief and improvement in mobility. There was rupture of orthopedic balloon in one patient and it was replaced, then procedure was continued with no complications. In all cases there was successful creation of the cavity in the treated vertebra (Figure 3). Cement leakage was observed in one case. There were no neurological complications in all cases and there were no infections and no symptomatic pulmonary embolism.

Figure 3: Lateral radiograph showing cement and affected vertebra at 1 year follow-up

Discussion

This study shows results of balloon kyphoplasty in treatment of osteoporotic vertebral compression fracture. In our series of 30 cases, the majority were female (73.3%) similar to other study.[26] Measure of clinical outcome for pain, mean VAS score was 8.1 ± 0.9 preoperatively which improved to 2.4 ± 0.3 at final follow-up which shows p value less than 0.05 by paired t-test and is statistically significant. This can improve sagittal profile, which decreases compensating activity of the muscles.[27, 28] The ODI score also shows significant improvement after surgery, which improved from 71.4 ± 3.4 to 26.0 ± 4.8 at one day and 21.2 ± 5.5 at final follow-up. Mean kyphotic angle was improved from 16.4 ± 3.5 to 5.6 ± 1.7 postoperatively and 8.4 ± 1.6 at final follow-up. The significant increment in mean anterior vertebral height was observed i.e., from 51 ± 7.3% before surgery to 75.5 ± 7.4% at one day after surgery and 71.2 ± 3.2% at the last follow-up. The result shows functional improvement in VAS score and ODI score which is similar to other studies.[29] Our study showed a rapid decrease in pain, with a significant improvement in VAS score post-operatively.

Our study shows an improvement in sagittal alignment of spine and vertebral body height was achieved in most of the patients. A mean correction of 8.07° was achieved in local kyphosis which is similar to the 8.8° in another study.[30] The cement leakage was 9% following kyphoplasty and 41% after vertebroplasty in other clinical studies.[30] In our series, it was reported in one case (3.3%) which shows better results. The study shows no neurological complications, no infection and no symptomatic pulmonary embolism. Thus, percutaneous kyphoplasty showed low complication rates with good outcome.

Conclusion

Percutaneous balloon kyphoplasty for treatment of symptomatic osteoporotic vertebral compression fracture is a good option with better pain relief, quality of life and with low complication rates.

References

1. Glaser DL, Kaplan FS. Osteoporosis: Definition and clinical presentation. Spine 1997; 22: 12S-16S.
2. Iqbal MM, Sobhan T. Osteoporosis: A review. Missouri Med. 2002; 99: 19-24.
3. Johnell O. Advances in osteoporosis: Better identification of risk factors can reduce morbidity and mortality. J Intern Med. 1996; 239: 299-304.

4. Verbrugge LM, Lepkowski JM, Imanaka Y. Comorbidity and its impact on disability. Milbank Q. 1989; 67: 450-84.

5. Silverman SL. The clinical consequences of vertebral compression fracture. Bone 1992; 13: S27-31.

6. Gold DT. The clinical impact of vertebral fractures: Quality of life in women with osteoporosis. Bone 1996; 18: 185S-89S.

7. Belmont Jr PJ, Polly Jr DW, Cunningham BW, Klemme WR. The effects of hook pattern and kyphotic angulation on mechanical strength and apical rod strain in a long-segment posterior construct using a synthetic model. Spine 2001; 26: 627-35.

8. White AA 3rd, Panjabi MM, Thomas CL. The clinical biomechanics of kyphotic deformities. Clin Orthop Relat Res. 1977; 128: 8-17.

9. Gaitanis IN, Carandang G, Phillips FM, Magovern B, Ghanayem AJ, Voronov LI, Havey RM, Zindrick MR, Hadjipavlou AG, Patwardhan AG. Restoring geometric and loading alignment of the thoracic spine with a vertebral compression fracture: Effects of balloon (bone tamp) inflation and spinal extension. Spine J. 2005; 5: 45-54.

10. Yuan HA, Brown CW, Phillips FM. Osteoporotic spinal deformity: A biomechanical rationale for the clinical consequences and treatment of vertebral body compression fractures. J Spinal Disord Tech. 2004; 17: 236-42.

11. Pluijm SM, Tromp AM, Smit JH, Deeg DJ, Lips PT. Consequences of vertebral deformities in older men and women. J Bone Miner Res. 2000; 15: 1564-72.

12. Kado DM, Browner WS, Palermo L, Nevitt MC, Genant HK, Cummings SR. Vertebral body fractures and mortality in older women: A prospective study. Arch Intern Med. 1999; 159: 1215 -20.

13. Schlaich C, Minne HW, Bruckner T, Wagner G, Gebest HJ, Grunze M, Ziegler R, Leidig-Bruckner G. Reduced pulmonary function in patients with spinal osteoporotic fractures. Osteoporos Int. 1998; 8: 261-67.

14. Linville DA 2nd: Vertebroplasty and kyphoplasty. South Med J. 2002; 95: 583-87.

15. Cotten A, Boutry N, Cortet B, Assaker R, Demondion X, Leblond D, Chastanet P, Duquesnoy B, Deramond H. Percutaneous vertebroplasty: State of the art. Radiographics 1998; 18: 311-20.

16. Rapado A. General management of vertebral fractures. Bone 1996; 18: S191-S96.

17. Reginster JY, Minne HW, Sorensen OH, Hooper M, Roux C, Brandi ML, Lund B, Ethgen D, Pack S, Roumagnac I, Eastell R. Randomized controlled trial of risedronate on vertebral fractures in women with established postmenopausal osteoporosis. Osteoporos Int. 2000; 11: 83-91.

18. Dickman CA, Fessler RG, MacMillan M, Haid RW. Transpedicular screw-rod fixation of the lumbar spine: Operative technique and outcome in 104 cases. J Neurosurg. 1992; 77: 860-70.

19. Essens S, Sacs BL, Drezyin V. Complications associated with the technique of pedicle screw fixation: A selected survey of ABC members. Spine 1993; 18: 2231-39.

20. Silverman SL. The clinical consequences of vertebral compression fracture. Bone 1992; 13: S27-31.

21. Phillips FM, Wetzel FT, Lieberman I, Campbell-Hupp M. An *in vivo* comparison of the potential for extravertebral cement leak after vertebroplasty and kyphoplasty. Spine 2002; 27: 2173-78.

22. Liebermann I, Reinhardt MK. Vertebroplasty and kyphoplasty for osteolytic vertebral collapse. Clin Orthop. 2003; 415: 176-86.

23. Galibert P, Deramond H, Rosat P, Le DG. Preliminary note on the treatment of vertebral angioma by percutaneous acrylic vertebroplasty. Neurochirurgie 1987; 33: 166-68.

24. Spivak JM, Johnson MG. Percutaneous treatment of vertebral body pathology. J Am Acad Orthop Surg. 2005; 13: 6-17.

25. Boszczyk BM, Bierschneider M, Hauck S, Beisse R, Potulski M, Jaksche H. Transcostovertebral kyphoplasty of the mid and high thoracic spine. Eur Spine J. 2005; 14: 992-99.

26. Bouza C, López-Cuadrado T, Almendro N, Amate JM. Safety of balloon kyphoplasty in the treatment of osteoporotic vertebral compression fractures in Europe: A meta-analysis of randomized controlled trials. Eur Spine J. 2015; 24: 715-23.

27. Ledlie JT, Renfro MB. Kyphoplasty treatment of vertebral fractures: 2-year outcomes show sustained benefits. Spine 2006; 31: 57–64.

28. Grohs JG, Matzner M, Trieb K, Krepler P. Minimal invasive stabilization of osteoporotic vertebral fractures: A prospective nonrandomized comparison of vertebroplasty and balloon kyphoplasty. J Spinal Disord Tech. 2005; 18: 238-42.

29. Chia-Wei YU, Ming H, Lih-Huei, Chi-Chien N. Percutaneous balloon kyphoplasty for the treatment of vertebral compression fractures. BMC Surg. 2014; 14: 3.

30. Phillips FM, Ho E, Campbell-Hupp M, McNally T, Wetzel FT, Gupta P. Early radiographic and clinical results of balloon kyphoplasty for the treatment of osteoporotic vertebral compression fractures. Spine 2003; 28: 2260-67.