Clinics of Surgery

Case Report ISSN: 2638-1451|Volume 11

Surgical Treatment of Kummell's Disease Using Biportal Endoscopy and Transpedicular application of Application of Escherichia Coli-Derived Recombinant Human Bone Morphogenic Protein-2: Technical Note

Young-Il Ko[1*], Hun-Chul Kim[2], Jin Young Lee[1], Hyeon Guk Cho[1], Jeong Woo Park[1] and Sang -Ho- Han[1]

[1]Endoscopic Spine Surgery Center, DaeChan Hospital, Incheon, Republic of Korea

[2]Department of spine surgery, Baro Seogu Hospital, Incheon, Republic of Korea

[*]Corresponding author:

Young-Il Ko,
Endoscopic Spine Surgery Center, Dae-Chan Hospital, 590, Inju-daero, Namdong-gu, Incheon, Republic of Korea

Received: 05 Jan 2025
Accepted: 22 Jan 2025
Published: 29 Jan 2025
J Short Name: COS

Citation:

Young-Il Ko. Surgical Treatment of Kummell's Disease Using Biportal Endoscopy and Transpedicular application of Application of Escherichia Coli-Derived Recombinant Human Bone Morphogenic Protein-2: Technical Note. Clin Surg. 2025; 11(3): 1-7

1. Abstract

1.1. Introduction

Kummell's disease involves delayed collapse of osteoporotic vertebrae, primarily affecting elderly patients with increased surgical risks. Conventional surgeries, such as corpectomy, often pose challenges due to significant blood loss and prolonged recovery. Minimally invasive methods, including biportal endoscopic spine surgery (BESS) and recombinant human Bone Morphogenetic Protein-2 (rhBMP-2), offer safer alternatives for effective treatment in high-risk patients.

1.2. Materials and Methods

This technique combined BESS for decompression with the transpedicular application of E. coli-derived rhBMP-2 and putty form hydroxyapatite (putty HA) for enhanced bone fusion and stability. Putty HA, known for its osteoconductive properties and ease of handling, was used to maintain graft integrity without washout, supporting bone regeneration. Through small incisions, rhBMP-2 and putty HA were applied to promote healing, followed by percutaneous pedicle screw placement for stabilization.

1.3. Results

The use of BESS with rhBMP-2 and putty HA achieved effective spinal decompression and vertebral stability while minimizing blood loss. Postoperative imaging confirmed solid fusion and alignment, while patients reported pain relief and improved mobility, along with shorter recovery times. The putty HA's cohesive properties proved beneficial in reducing graft displacement during surgery.

1.4. Conclusion

Combining BESS with rhBMP-2 and putty HA offers a viable, minimally invasive alternative for managing Kummell's disease in elderly patients. This approach enhances decompression and stabilization with fewer complications and promotes faster recovery. The addition of putty HA helps maintain graft stability, further supporting fusion success. Future studies are recommended to verify long-term outcomes and expand the clinical applications of this technique.

2. Introduction

Various treatment modalities have been proposed for Kummell's disease, including conservative management, cement augmentation, and in more severe cases, anterior or posterior corpectomy with anterior support [1]. However, considering that Kummell's disease predominantly affects elderly patients with poor medical conditions, the risks associated with surgery, such as significant blood loss and complications from an anterior approach, can be substantial. As such, spine surgeons are particularly interested in finding treatment methods that minimize patient morbidity, particularly in frail, elderly patients, through the least invasive means possible.With the advancement of biportal endoscopic spine surgery(BESS), the field of minimally invasive surgery has made significant strides. One of the key strengths of BESS is its ability to achieve adequate decompression through a minimal incision. Escherichia coli-derived recombinant human Bone Morphogenetic Protein-2 (rhBMP-2) is a powerful bone forming agent widely used in spine surgery. Recently, it has been used in various spine surgeries and successful fusion results have been reported [2,3]. Recently, Kim et al reported successful treatment of unstable spinal fracture by inserting rhBMP-2 into the vertebral body [4].This technical note aims to introduce a treatment method for Kummell's disease using BESS in conjunction with rhBMP-2.

3. Technical Note

3.1. Case 1. (Video 1)

An 88-year-old female patient who had undergone conservative treatment after a slip down 3 months ago presented to the hospital with uncontrolled back pain. A fracture of L1 vertebral body were confirmed on X-ray, and an unstable pattern was confirmed on flexion/extension imaging. (Figure 1a, b), MRI shows fracture of the L1 body, intervertebral cleft sign, and posterior bulding with cord compression. (Figure 1c) The patient's strength in both lower extremities was motor grade 3. Accordingly, wide posterior decompression was performed unilaterally at the T12-L1 level using BESS, posterior fusion was performed on the opposite side, and putty form Hydroxyapatite with collagen (OssGen, Daegu, Republic of Korea; putty HA) was injected into the vertebral body through the pedicle. rh-BMP2 with HA carrier (Novosis, CGbio, Republic of Korea) was inserted, and a pedicle screw was inserted percutaneously. The surgery time took 2 hours, and the estimated blood loss pre- and post-operatively using hemoglobin was 350ml [5].

3.2. Reduction with Surgical Table

One of the characteristics of Kummell's disease is that it is unstable. For patients with Kummell's disease, reduction occurs when placed in prone position on the surgical table (Figure 2) Stability can be confirmed by taking a dynamic radiograph before surgery. Both the four-poster frame and the Wilson frame can be used for surgery, but better results have been reported for the four-poster frame in the correction [6].

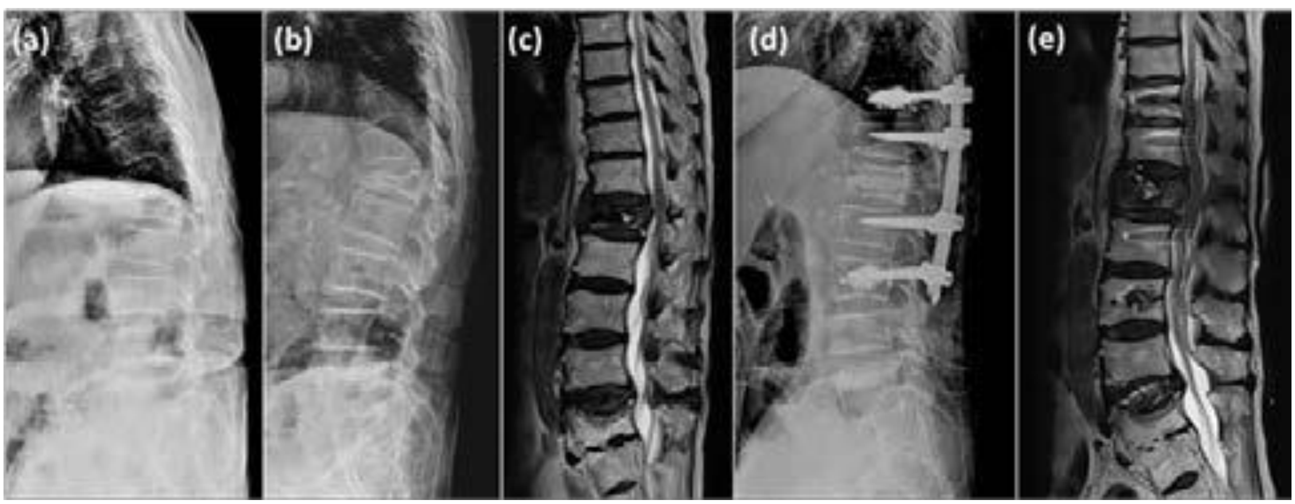

Figure 1:A collapsed L1 vertebra was confirmed on the plain lateral radiograph, and an unstable appearance was confirmed on flexion (a) and extension (b). (c) T2 weighted sagittal MRI shows intravertebral cleft sign and cord compression due to posterior bulging of the vertebral body. (d, e) After surgery, the reduced L1 vertebra and the decompressed appearance of the spinal cord on MRI are confirmed.

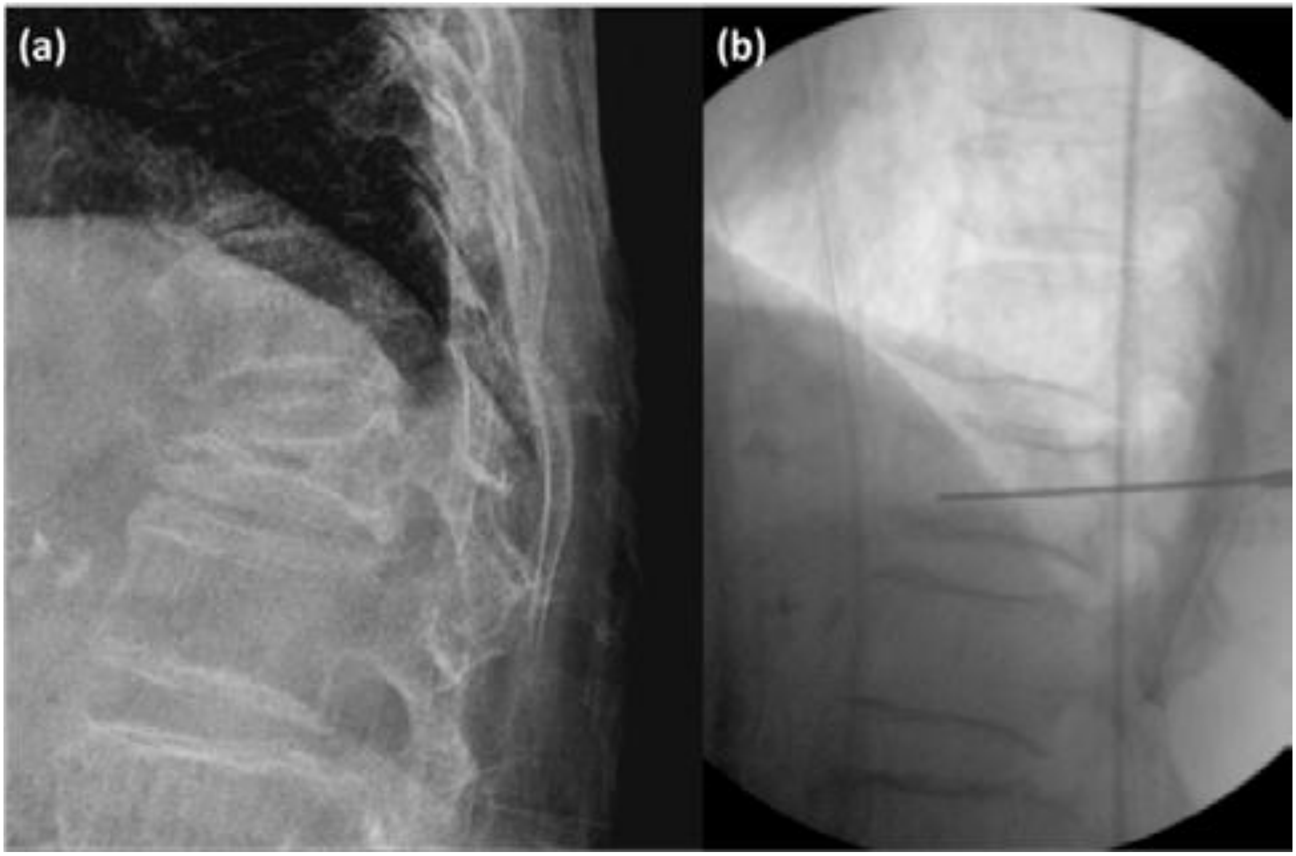

Figure 2 (a): Collapse of L1 vertebral body was confirmed on the preoperative lateral radiograph. (b) The collapsed vertebral body can be seen reduced in the lateral view taken with a C-arm image intensifier after being placed in a prone position on a four-poster frame in the operating room.

3.3. Bilateral Posterior Decompression of the Spinal Cord Using BESS

On MRI, the body protrudes posteriorly, compressing the spinal cord, and if there are neurologic symptoms, decompression is necessary even if positional reduction has occurred. In this patient, because compression of the spinal cord was confirmed at the T12-L1 level, bilateral decompression was performed using the Lt side approach using BESS. The range of decompression should be wider to the cranial and caudal compared to bilateral decompression in spinal stenosis performed at the general lumbar. This is because the cord is pushed posteriorly by the anterior lesion, so if only focal decompression is performed, buckling of the cord may occur at the adjacent level. Therefore, in the case of the distal lamina, use a burr to grind the upper 1/3 of the lamina until the cortical bone comes out, and then carefully remove the ligamentum flavum and upper lamina together.

3.3. Decoration of Lamina on the Contralateral Side Using Biportal Endoscopy and Putty HA Graft Using Funnel

Using a C-arm image intensifier as a guide, two incisions are made on the opposite T12 and L1 lamina. First, a blunt instrument is used to separate the soft tissue and bone. Next, an endoscope and shaver are inserted, and the shaver is used to clear away soft tissue. Then, a curette is employed to remove the superficial flavum to expose as much bone as possible. Subsequently, a burr is used for decortication of the T12, L1, and L2 laminae. Finally, a funnel is inserted to apply putty HA, pre-soaked in saline, onto the lamina surface (Figure 4).

3.4. Percutaneous Insertion of Putty Type HA and rh-BMP2 with Serial Dilator

First, insert a narrow needle into the pedicle, then insert a wire and serially expand the pedicle using a wide dilator. (Figure 5a) Afterwards, insert the funnel and insert through the hole in the following order: putty HA – rhBMP-2 with HA carrier – putty HA to prevent leakage of rhBMP-2 (Figure 5e).

3.5. Percutaneous Pedicle Screw Insertion with Cement Augmentation for UIV and LIV

Next, insert the percutaneous pedicle screw. At this time, cement(polymethylmethacrylate) augmentation is performed on UIV and LIV together to prevent proximal and distal junctional failure. One of the important issues in patients with osteoporosis is implant failure that occurs proximal or distal. When inserting a pedicle screw, augmentation of cement around the screw increases the pull out strength of the screw, which has been reported to be useful when used in patients with osteoporosis [7].

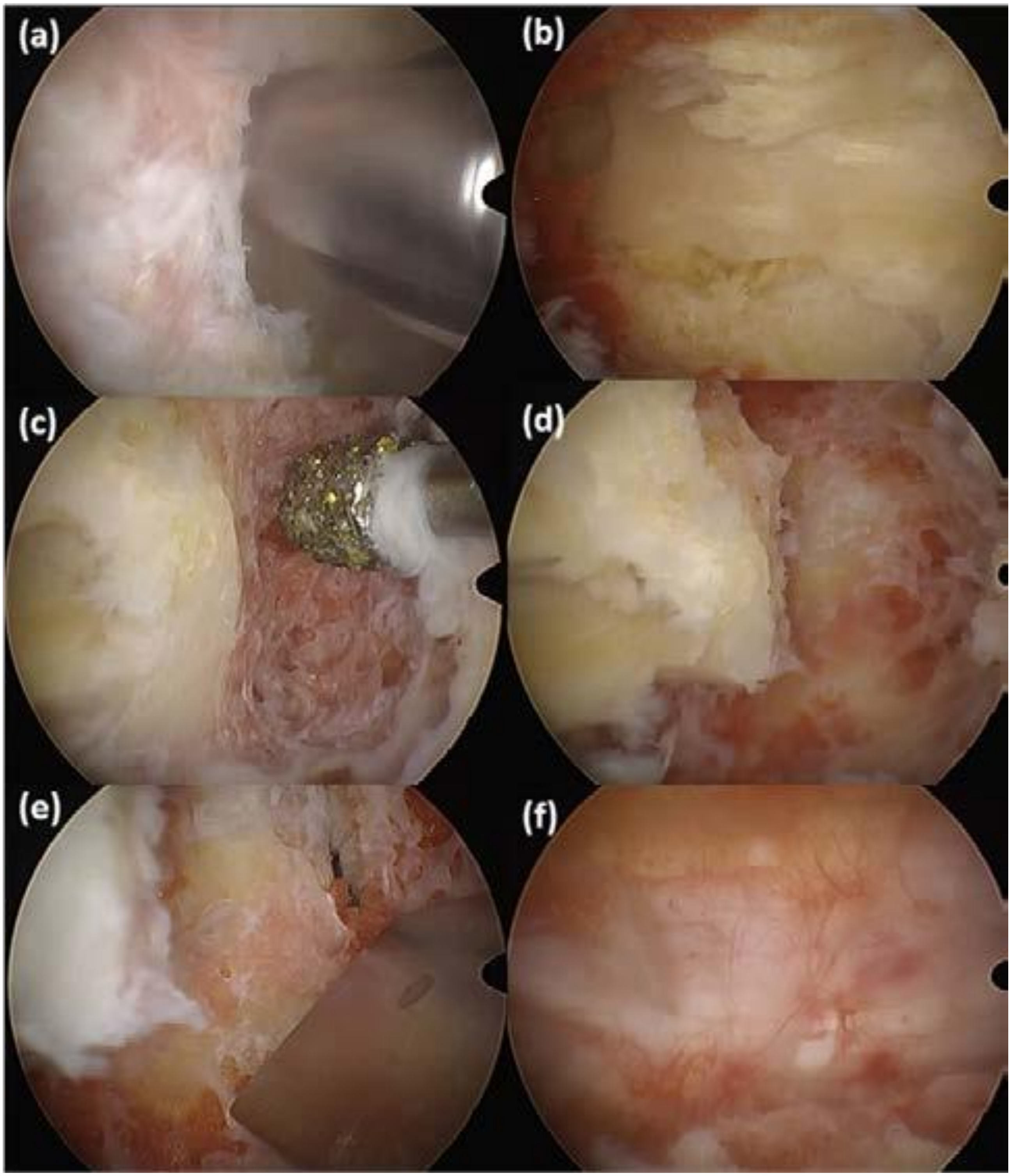

Figure 3: Decompression process at T12-L1 level using BESS.(a) Grind the lower portion of the T12 lamina using a burr. (b) The attachment site of the ligamentum confirmed after grinding the lamina. (c) Grinding the upper portion of L1 lamina using a 3mm match head burr. (d) Cancellous bone was removed using a burr, leaving only the far cortex. (e) Carefully create a crack in the far cortex using a chisel and remove it along with the ligamentum flavum. (f) View of the decompressed spinal cord after removal of the ligamentum flavum.

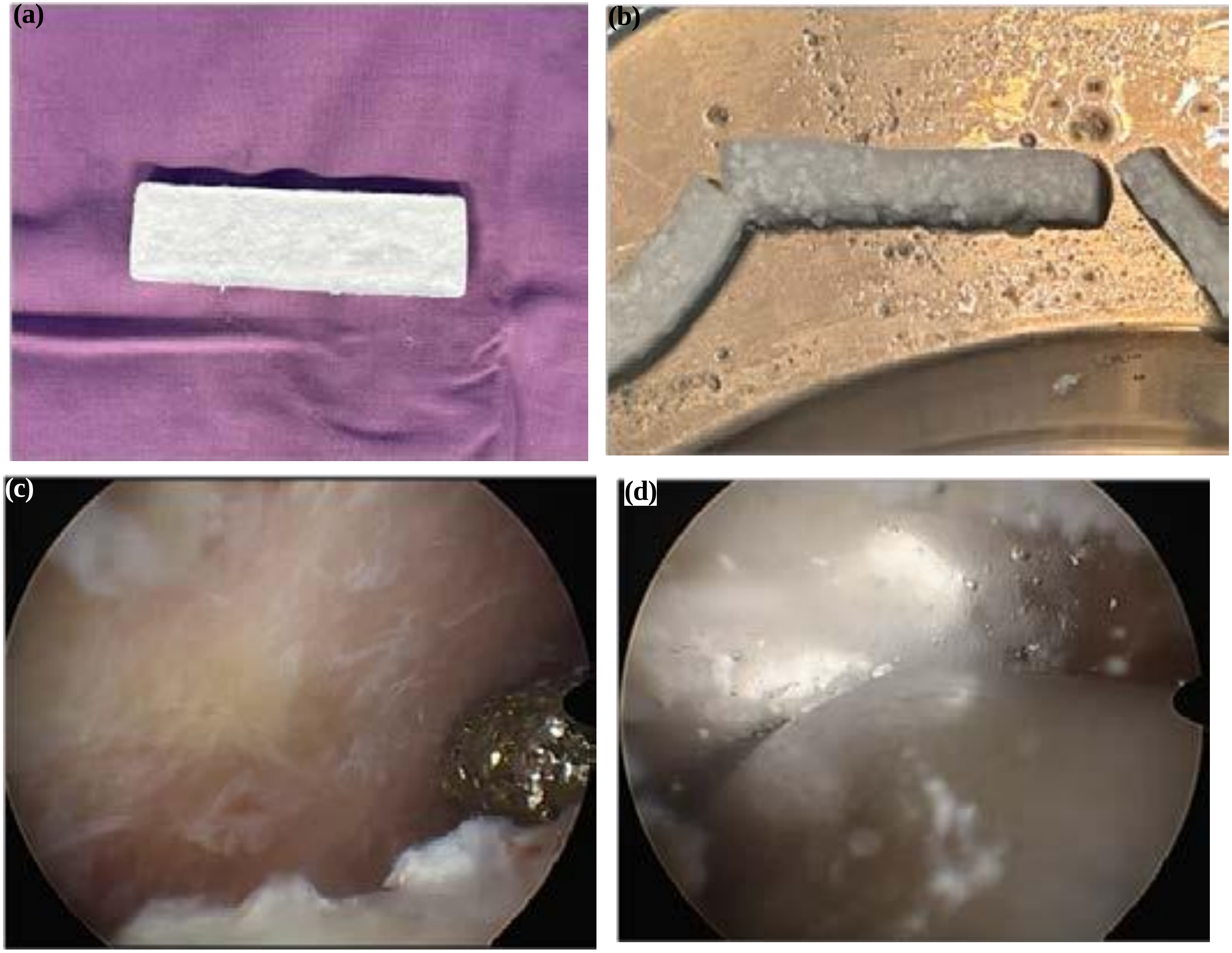

Figure 4 (a): Putty HA in product state. (b) State soaked in saline. (c) Decortication of lamina with burr using BESS. (d) Insertion status of putty HA.

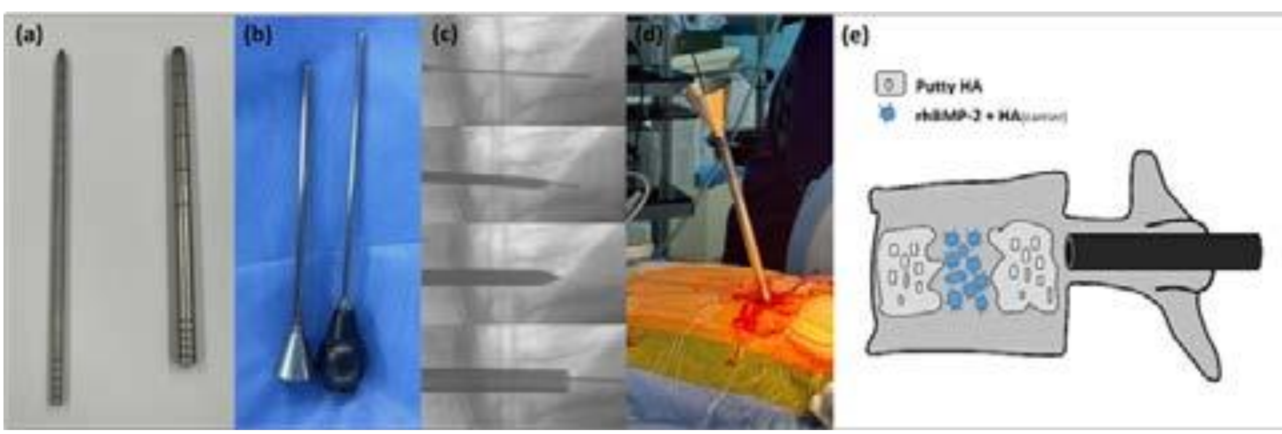

Figure 5 (a): Serial dilator for gradual expansion of the pedicle hole. (b) Funnel for inserting graft material and BMP. (c) Intraoperative radiograph image of gradual expansion and insertion from the serial dilator to the funnel (d) Intraoperative photo of inserting graft material using a funnel. (e) Schematic diagram of inserting putty HA, rhBMP2 with HA carrier, and putty HA into the vertebral body using a funnel.

3.6. Case 2. Collapse of The Vertebral Body After Cement Insertion in Kummell's Disease

A 74-year-old female patient suffered from a stable burst fracture of T12 and her symptoms improved after intravertebral balloon kyphoplasty, but she complained of severe, uncontrollable back pain that persisted for a month after the surgery. On MRI, vertebral collapse was confirmed, and there was no evidence of spinal cord compression(Figure 6). Bilateral posterior fusion and percutaneous pedicle screw insertion with cement augmentation using BESS were performed in a situation where percutaneous BMP insertion was not possible.

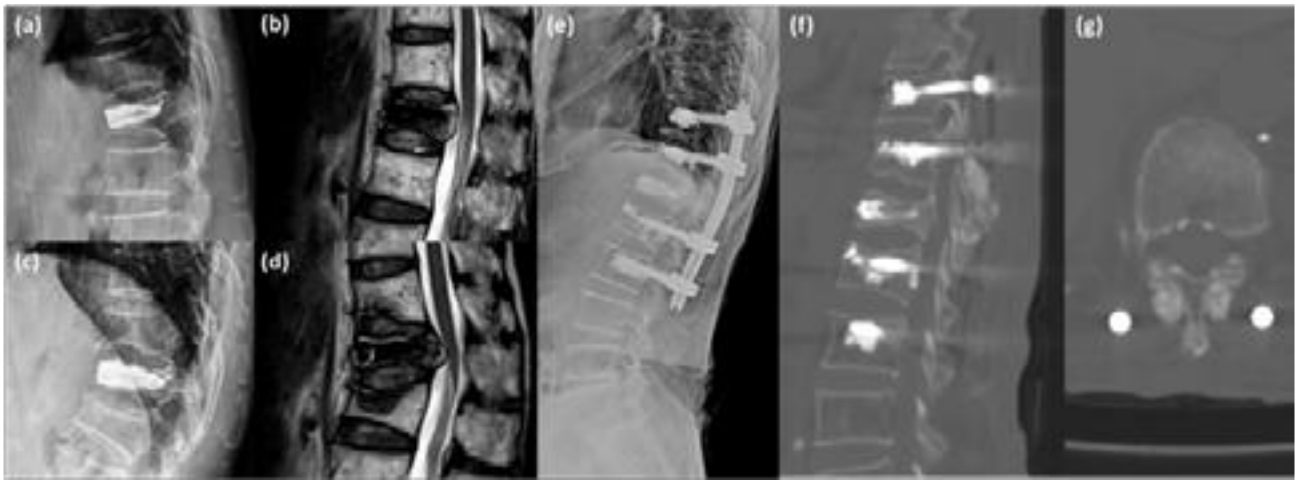

Figure 6 (a): Lateral radiograph and (b) T2 weighted sagittal MRI taken after balloon kyphoplasty for compression fracture of L1. (c, d) One month after kyphoplasty, collapse of the L1 body and compression fracture of the upper and lower adjacent vertebras were confirmed. (e) Lateral radiograph after posterior fusion and percutaneous screw fixation using BESS. (f, g) Posterior fusion material confirmed on postoperative CT scan.

4. Discussion

In the past, in the case of unstable burst fractures involving the canal that occurred at an old age, surgical treatment at the cost of a large amount of bleeding was inevitable for posterior and anterior decompression. Patient morbidity and mortality caused by blood loss, general anesthesia, and long surgery time were long-standing problems. Because this problem can be more than just a patient's fracture or neurological sequelae, many attempts have been made to treat these patients by performing surgery with as little blood loss as possible. The methods include vertebroplasty and kyphoplasty, which insert cement into the vertebral body. In the case of this procedure, there may be cases where the vertebral body and cement cannot withstand the pressure and collapse (case 2), and new fractures may occur in segments adjacent to the cement insertion level. There are also reports that the risk of cement leakage increases when an IVC is present.8 Park et al also reported a method of providing anterior support by inserting a cage into the vertebral body through the pedicleKim et al. [9]Reported that solid fusion was achieved within 100 days through transpedicular intravertebral rhBMP-2 insertion in patients with unstable spinal fractures, including elderly patients [4].Bone morphogenetic proteins (BMPs) are crucial for various developmental processes, such as heart, nervous system, and bone formation. In a recent meta-analysis, E. coli-derived rhBMP-2 was reported to have a superior fusion rate compared to autogenous iliac bone graft during lumbar fusion.10 Recently, several studies have reported successful bone union through BMP [2,4,11]. A limitation of the existing BESS has been pointed out because it is a water flow-based surgery, so bone graft material is washed out, making additional posterior fusion difficult in addition to interbody fusion. Hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$) is the most significant inorganic component of teeth and bone, and as an osteoconductive agent, it is widely used for bone union in the area of fracture and spine surgery [12]. Putty form HA with collagen is a material that has been mainly used in the dental field because it is easy to change into various sizes and shapes and has excellent hemostatic properties [13,14]. Because HA can be maintained without being washed out by collagen, such properties were used in these cases. In addition, BESS is performed by detaching the muscle from the bone and creating a space during surgery, so if the graft is inserted and water is not supplied, the inflated space contracts and presses the graft material and decorated posterior bony structure, which is advantageous for union.

There were three main reasons why surgery was needed through posterior midline incision in the past. First, if there was cord compression, it was necessary for posterior decompression through laminectomy. This can currently be performed through two small incisions through biportal endoscopy. The second is posterior fusion. This can also be performed through endoscopy as described in this technical note. Next is pedicle screw insertion, which became possible through stab incision with the development of percutaneous screw insertion devices. In this study, surgery was performed by combining these minimal invasive surgery techniques, and the transpedicular intravertebral BMP insertion technique was performed on the vertebral body [4].The surgical procedure described in this technical note can be performed when the fracture site is unstable and positional reduction is possible, even if the fracture is invading the canal due to posterior bulging of the vertebra. In cases where the fixed bone fragment compresses the cord posteriorly, it is not easy to obtain sufficient compression pressure through posterior decompression alone, so anterior or posterior corpectomy should be considered in these cases. Despite the limitations, patients who meet the indications for this technique can be treated with less blood loss and paraspinal soft tissue damage. Further studies and long-term follow-up are warranted to fully assess the benefits and efficacy of this technique

5. Conclusion

This technical note highlights the efficacy of BESS combined with rhBMP-2 for treating Kummell's disease. This minimally invasive approach reduces the risks associated with traditional surgical techniques, such as blood loss and complications, particularly in elderly patients. By achieving effective spinal decompression and stabilization with minimal morbidity, BESS and rhBMP-2 offer a promising alternative for managing this condition, warranting further investigation and long-term evaluation.

6. Acknowledgments:

Young-Il Ko, Hun-Chul Kim and Jin-Young Lee have equally contributed to this work as first author.

7. Statements and Declarations

Competing Interests: Each author certifies that he has no commercial associations that might pose a conflict of interest in connection with the submitted article

References

1. Ko Y-I, Ko M-S, Bang C, Park H-Y, Kim S-I, Kim Y-H. Understanding Kummell's Disease: Definition, Diagnosis, Pathophysiology, and Treatment. J Korean Soc Spine Surg.2024;31(1):23-29.
2. Cho JH, Lee JH, Yeom JS. Efficacy of Escherichia coli-derived recombinant human bone morphogenetic protein-2 in posterolateral lumbar fusion: an open, active-controlled, randomized, multicenter trial. Spine J. Dec 2017;17(12):1866-1874.
3. Im SK, Lee JH, Lee KY, Yoo SJ. Effectiveness and Feasibility of Injectable Escherichia coli-Derived Recombinant Human Bone Morphogenetic Protein-2 for Anterior Lumbar Interbody Fusion at the Lumbosacral Junction in Adult Spinal Deformity Surgery: A Clinical Pilot Study. Orthop Surg. Jul 2022;14(7):1350-1358.
4. Kim YH, Lee JS, Ha KY. Application of Escherichia coli-Derived Recombinant Human Bone Morphogenic Protein-2 to Unstable Spinal Fractures. Bioengineering (Basel). Sep 22 2023;10(10).
5. Gross JB. Estimating allowable blood loss: corrected for dilution. Anesthesiology. Mar 1983;58(3):277-80.
6. Park HY, Kim YH, Ha KY, Chang DG, Kim SL, Park SB. Are the Choice of Frame and Intraoperative Patient Positioning Associated with Radiologic and Clinical Outcomes in Long-instrumented Lumbar Fusion for Adult Spinal Deformity? Clin OrthopRelat Res.2022;480(5):982-992.
7. Elder BD, Lo SF, Holmes C, et al. The biomechanics of pedicle screw augmentation with cement. Spine J. 2015;15(6):1432-45.
8. Nakamae T, Yamada K, Tsuchida Y, Osti OL, Adachi N, Fujimoto Y. Response to: Risk Factors for Cement Loosening after Vertebroplasty for Osteoporotic Vertebral Fracture with Intravertebral Cleft: A Retrospective Analysis. Asian Spine J. 2019;13(1):178-179.
9. Park HJ, Kim HB, You KH, Kang MS. Percutaneous transpedicular intracorporeal cage grafting for Kümmell disease. Acta Neurochir (Wien). 2022;164(7):1891-1894.
10. Liu S, Wang Y, Liang Z, Zhou M, Chen C. Comparative Clinical Effectiveness and Safety of Bone Morphogenetic Protein Versus Autologous Iliac Crest Bone Graft in Lumbar Fusion: A Meta-analysis and Systematic Review. Spine (Phila Pa 1976). 2020;45(12):E729-e741.
11. Son HJ, Chang BS, Chang SY, Park HS, Kim H. Anterior Cervical Discectomy and Fusion Using Escherichia coli-Derived Recombinant Human Bone Morphogenetic Protein-2: A Pilot Study. Clin Orthop Surg. Dec 2022;14(4):557-563.
12. Litak J, Czyzewski W, Szymoniuk M. Hydroxyapatite Use in Spine Surgery-Molecular and Clinical Aspect. Materials (Basel). 2022;15(8).
13. Ku JK, Hong I, Lee BK, Yun PY, Lee JK. Dental alloplastic bone substitutes currently available in Korea. J Korean Assoc Oral Maxillofac Surg. 2019;45(2):51-67.
14. Neiva RF, Tsao YP, Eber R, Shotwell J, Billy E, Wang HL. Effects of a putty-form hydroxyapatite matrix combined with the synthetic cell-binding peptide P-15 on alveolar ridge preservation. J Periodontol. 2008;79(2):291-9.