Asian Biomedicine Vol. 6 No. 5 October 2012; 723-729 DOI: 10.5372/1905-7415.0605.113

Original article

A modified posterior spinal fusion technique: surgical technique and clinical outcome in minimal 2-year follow-up

Yongsak Wangroongsub, Chaiyos Chaichankul
Department of Orthopedics, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand

Background: Fusion of the spine region for congenital, traumatic, and degenerative lesions is more common now. Many orthopedic surgeons prefer posterior arthrodesis to restore the stability. Several studies have reported benefits, technical demands, clinical results, and postoperative complications with each method. For lumbar spine fusion, the best technique for a particular patient remains controversial.

Objective: We described a technique of posterior spinal fusion that can achieve solid fusion and produce clinical success.

Method: Between June 2008 and May 2010, a single surgeon treated 46 patients with this modified technique of posterior spinal fusion. All patients underwent postoperative computed tomography (CT) with coronal and sagittal three-dimensional reconstruction in assessing lumbar spine fusion. All patients were instructed to complete a self-assessment Oswestry Disability Index (ODI) questionnaire. These patients were analyzed for clinical outcome and fusion rate.

Results: The study group included 24 women and 22 men with a mean age of 71.2. Mean operating time was 106 minutes in a single-level fusion, 133 minutes in a two-level fusion, 210 minutes in a three-level fusion, and 288 minutes in a four-level fusion. The amount of blood loss during the operation and on the first postoperative day was 632 ml in a single-level fusion, 738 ml in a two-level fusion, 986 ml in a three-level fusion, and 1122 ml in a four-level fusion. There were postoperative complications in two patients. The minimum follow-up period was two years. Postoperative ODI was reduced significantly and had evidence of spinal fusion in CT scan assessing.

Conclusions: This posterior spinal fusion technique is effective in degenerative lumbar disease. Success rates have also been noted. This method of fusion can give the osseous fusion. It may also improve the clinical outcome. This modified posterior spinal fusion technique has some benefits when comparing to the previous methods.

Keywords: Clinical outcome, computed tomography (CT), posterior lumbar fusion, Oswestry Disability Index (ODI) questionnaire, spinal fusion

The number of patients was diagnosed for the spinal disease conditions are increasing so fusion procedure of the spinal region is more common, especially at lumbar spine. Surgical fusion of the spine is indicated to restore stability for immediate postoperative stability of the construct. This procedure is an important method to stabilize the spine after decompression surgery. Different surgical techniques can be used to achieve lumbar fusions [1]. The fusion methods with a posterior approach are classified into posterolateral fusion (PLF), posterior lumbar interbody fusion (PLIF), and PLIF combined with PLF.

It has been shown that all fusion techniques used in the current studies have the potential to reduce pain, decrease disability and create an osseous fusion in patients. Clinical outcomes have varied in different posterior spinal fusion techniques, but the achievement of a solid arthrodesis remains a primary goal of all lumbar fusion procedures. According to authors' knowledge, no studies describe about this modified posterior spinal fusion technique.

Correspondence to: Chaiyos Chaichankul, MD, Department of Orthopedics, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand. E-mail: chaichankul@yahoo.com

Method

Between June 2008 and May 2010, this modified technique of posterior spinal fusion procedure was done in 46 patients with minimum follow-up of two years. Patients who underwent this technique were evaluated. All patients included in the current study were referred for x-ray preoperative and magnetic resonance (MR) imaging. This procedure was performed by a senior author with the same operative technique performed in all operations. Inclusion criteria included patients undergoing fusion for degenerative conditions such as spinal stenosis, spondylolisthesis, degenerative disc disease, and adjacent segment stenosis. Additional anomalies of lumbar spine such as incomplete fusion of the dorsal arches were excluded.

All patients had instrumented with pedicle screws and rods. In addition, operating time, the amount of blood loss during operation and on the first postoperative day, and complications were recorded. The clinical outcome assessment was based on ODI scores. Statistical analysis of the data was performed using SPSS 17.0 software (SPSS Inc., Chicago, IL).

Informed consents were obtained from all patients who participated in this procedure. The Ethics Committees at our center approved the study and the study proposal was approved by the Institutional Review Board.

Surgical technique

- Make a midline longitudinal skin and subcutaneous tissues incision along the spinous processes.
- The dissection is kept as close to the midline as possible. This reduces bleeding from the paraspinal muscles.
- The dissection is carried out in the subperiosteal plane to allow good bony part identification.
- Divide the lumbodorsal fascia and the paraspinal muscles from the sides of the spines with Cobb elevator.
- The dissection is carried out from the spinous process to the laminae. The lamina and the facets joint are then exposed.
- Continue the exposure of the paraspinal muscles until expose the facet joint capsule.
- The exposure is stopped at the lateral side of the facet joint, without extension to the transverse process.
- Instrumentation can be performed under fluoroscopic in the selected levels.
- Following instrumentation, decompression can be done.
- After decompressive surgery and instrumented pedicle screws were carried out, the fusion process started.
- Remove the joint capsule with an electrocautery to expose the facet joint (**Figure 1**).
- Remove the cartilage from the facets with using a high-speed power burr. Make a trough by placing the high-speed power burr at the area between superior and inferior articular processes (**Figure 2**).
- Move the high-speed power burr carefully for making the raw surface to bridge the pars interarticularis between each level.
- Level the area down to allow the graft to fit against the facets and pars interarticularis at each level.
- Care should be taken to avoid injury to the dural sac.
- Local cancellous bone grafts harvested from laminectomy procedure were used.
- Each cancellous bone chip was measured approximately in $3 \times 3 \times 3$ mm^3.
- Packing the trough with cancellous bone chips. Pack it fully with chips by the punch (**Figure 3**).
- The bone grafts should not extend beyond the dural sac.
- Checking the location of bone grafts before closing the wound.
- Suture the fascia and the subcutaneous tissue carefully to eliminate dead space and close the skin with a subcuticular suture or non-absorbable skin suture technique.

Figure 1. Demonstrating the facet joints after removing the joint capsules

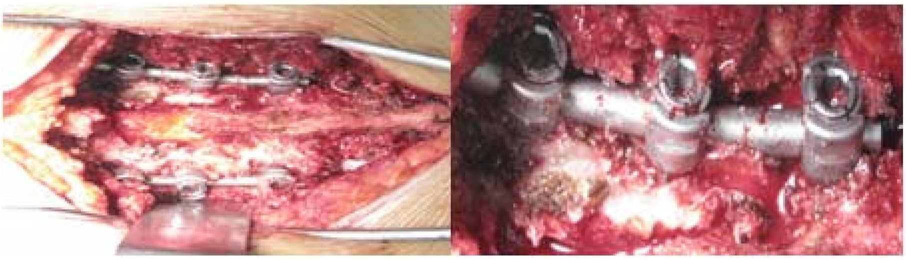

Figure 2. Demonstrating a trough area between superior and inferior articular processes.

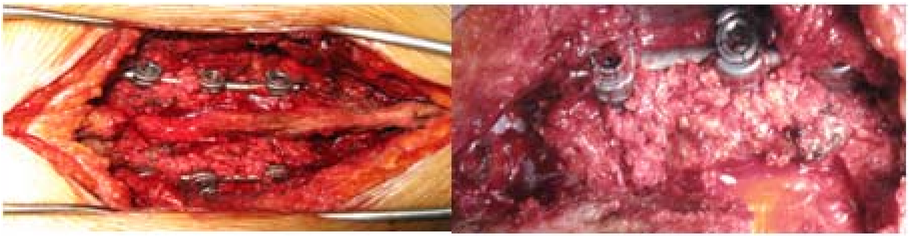

Figure 3. Demonstrating packing the trough with cancellous bone chips.

Postoperative course

Radiographic imagines of 46 patients were analyzed. Radiographs were taken after surgeries overall grade of fusion. A facet joint was judged to be fused if there was obliteration of the joint space with bridging bone between the superior and inferior articulating processes on axial images. The patients were reviewed for measurements at 1-month, 3-month, 6-month, and 1-year intervals thereafter. Forty-six patients had clinical outcomes data prospectively collected and underwent a fine-cut CT scan at one-year after surgery. CT scans were obtained with 1-mm thick continuous slices. Coronal and sagittal reconstructions were obtained on all scans. We performed CT imaging post-operatively for determined the osseous fusion. The facet joints were examined and then summarized into an A posterior fusion was judged as fused if there was continuous trabeculated bone connecting the pars articularis each level on coronal and/or sagittal reconstructed images

Follow-up examinations are typically conducted at 1-month, 3- month, 6- month, 1-year, and every year post-operatively. The ODI is a self-assessment questionnaire to evaluate a score of level of function at each time of follow-up. Statistical analysis was by SPSS version 17.0 software (SPSS Inc, Chicago, IL).

Results

The study group included 24 women and 22 men that ranged in age from 53 to 80 with a mean age of 71.2. Twenty-two patients (48%) underwent a single-level fusion, 14 patients (30%) underwent a two-level fusion, eight patients (17%) underwent a three-level fusion, and two patients (4%) underwent a four-level fusion. Mean operating time was 106 minutes (range 90–120) in a single-level fusion, 133 minutes (range 105–153) in a two-level fusion, 210 minutes (range 180–235) in a three-level fusion and 288 minutes (range 278–298) in a four-level fusion. The amount of blood loss during the operation and on the first postoperative day was 632 ml in a single-level fusion (range 520–770), 738 ml in a two-level fusion (range 678–880), 986 ml in a three-level fusion (range 910–1020), and 1122 ml in a four-level fusion (range 1012–1232).

Complications

Operative-related complications included one patient (a three-level fusion) who had superficial wound infection and postoperative requiring operative debridement, one patient (a four-level fusion) who had dural tear while using a high-speed power burr to make a trough area and requiring operative repair by Duragen . No device related complications were observed.

Clinical results

The functional outcomes assessed before and after surgery were ODI. All patients were assessed preoperatively and 1-month, 3- month, 6- month, 1-year, and every year post-operatively. Assessment of the ODI scores showed that 46 patients completed the questionnaire. There was significant improvement of the ODI score following surgery. Mean preoperative ODI showed significant decrease from 47.6±6.2 to 25.3±11.7 (p <0.001) at the 6-month follow-up. The improvement continued over the following 18 months with ODI decreasing to 20.5±8.4 at the 2-year visit. All of these results are significant with p <0.05.

Radiographic fusion rate:

Postoperative CT imaging of all patients were shown that was fused if there was obliteration of the joint space in a facet joint with bridging bone between the superior and inferior articulating processes on axial images (**Figure 4**). In addition, there was continuous trabeculated bone connecting the pars articularis each level on coronal and/or sagittal reconstructed images (**Figure 5**).

Discussion

Most degenerative spine conditions are considered for decompression procedure that causes segmental instability. Spinal fusion is the standard treatment after this procedure [1-3]. The goal of any spinal fusion is to obtain a solid arthrodesis. Surgical fusion of the lumbar spine is an important method to stabilize the spine after decompressive surgery by removing the motion of the segment using instrumented pedicle screws. A motion segment includes the spinous process, the transverse process, the laminae, the facet joints, and the vertebral body. Some of the posterior spinal fusion techniques are based on obtaining fusion at more than one of these sites. Instrumentation provides temporary stability of the spine until a bridge of bone connects the vertebrae together (fusion). Although the instrumentation can provide immediate stability to the spine, the instrumentation will loosen or fail if fusion of the spine segment does not occur. A fusion occurs when bone connects one vertebra to another. Bone fusion replaces the instrumentation and stabilizes the vertebra.

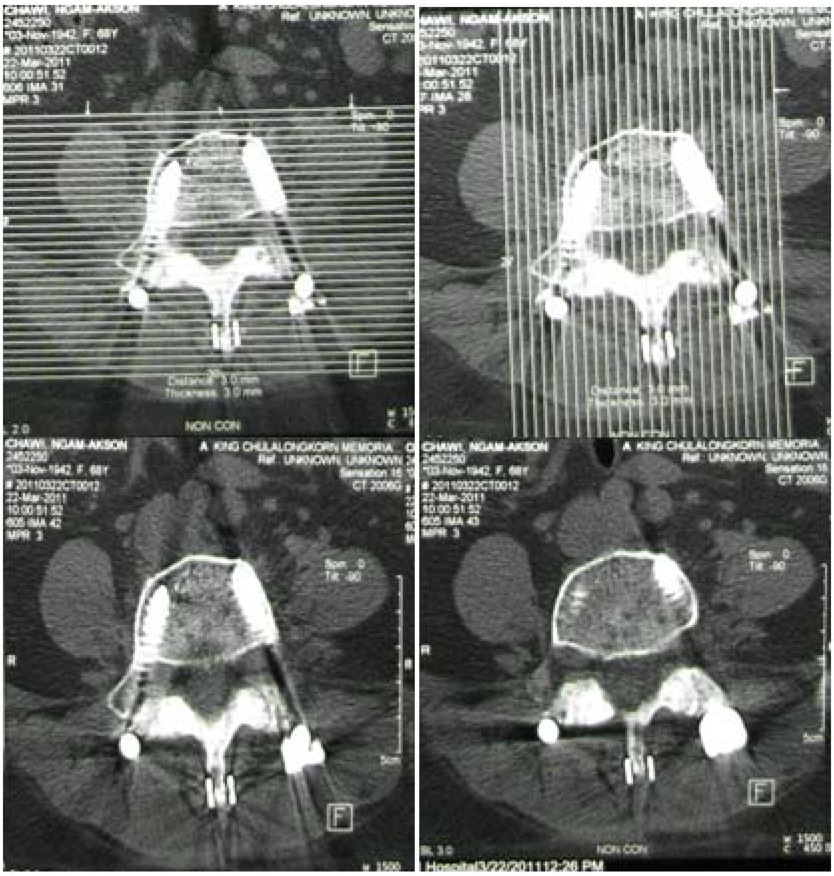

Figure 4. Postoperative CT scan taken 1 year after surgery shows that fusion was complete at the L4/5 level.

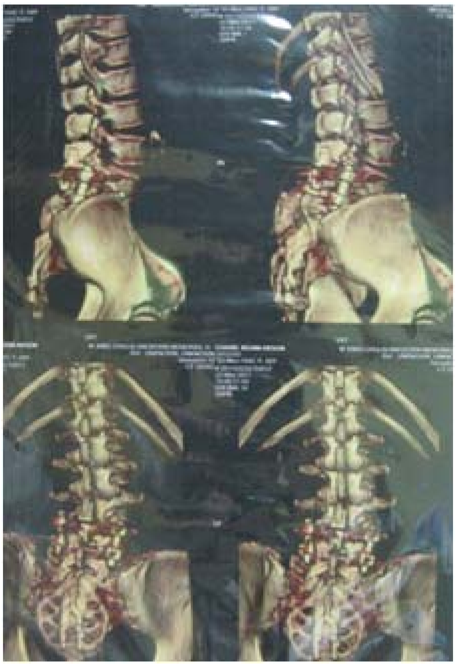

Figure 5. CT reconstruction

Flexion–extension radiographs can be used to assess fusion status. However, it is difficult to estimate fusion on a plain radiograph. There are some concerns regarding this modality and the reliability of the reported fusion rates [4-6]. It has been reported that a much higher fusion rate is determined by assessment using flexion–extension radiographs than histological evaluations. More recently, CT has become the superior diagnostic imaging method of choice to evaluate spinal fusions. Therefore, we used CT for imaging bony detail in the spine to assess the degree of osseous fusion. Thin-section helical CT scanning has become the most reliable method for assessing fusion [7, 8]. Reformatted coronal and sagittal CT images make it possible to more clearly evaluate osseous continuity within the graft segment.

The clinical outcome of posterior lumbar fusions varies widely in the literature [9]. It has been shown that all fusion techniques used in the current study [10] have the potential to reduce pain, decrease disability, and create an osseous fusion in these patients. Stauffer RN et al. [11] noted that 60 percent achieved good results and 81 percent satisfactory results in a series of 177 patients who done PLF procedure. Some studies [12, 13] of PLIF are available with reports of superior fusion rate of the PLIF procedure. In Lidar et al.'s study [14], they concluded that PLIF is superior to PLF in disc space height maintenance and demonstrates a tendency toward higher fusion rates and no correlation between disc space height augmentation/maintenance and clinical outcome. Clinical outcome is similar for PLIF with bony transverse fusion vs. instrumented PLF. In our study, the mean reduction in ODI score was 20.5 at 2-year follow-up. The clinical outcome of this series is favorable for this modified posterior spinal fusion technique.

However, Kim et al. [15] reported that no significant differences in clinical results and union rates were found among PLF, PLIF and PLF+PLIF methods. We found that this modified spinal fusion technique can reduce operative time and reduce blood loss when comparing to previous methods. Many literatures reported about the complications after the posterior spinal fusion techniques [16-19].

We found that the rate of complications in this series was low. This current study found some postoperative complications in two patients, but both of them did not result in apparent disabilities. Many literatures have suggested that the creation of rigid segments may predispose to the degeneration of segments adjacent to a fusion [20-22]. This modified posterior spinal technique must address concerns about the development of adjacent segment degeneration (ASD) by comparing the results with various fusion techniques in future studies.

Conclusion

Achievement of a solid arthrodesis should be a primary goal whenever lumbar fusion surgery is undertaken. We report the effectiveness of this fusion technique in degenerative lumbar disease. Success rates have also been noted. Clinical outcome is favorable to this technique. We can rely on the small amount of bone grafts, which also can give the osseous fusion. This modified posterior spinal fusion technique has some benefits when comparing to the previous methods. The benefit include a greater the chance of osseous fusion through an increased area of graft contact by denuded cartilage at facet joints. This in turn provides good bleeding bone bed and a trough area to maintain chip grafts in the fusion zone as well as bone-to-bone bridging between each lamina with no soft tissue interposing between bridging bone graft. Thus it does not disrupt soft tissue extended to transverse process, which can minimize soft tissue trauma and reduce blood loss.

The authors have no benefits or funds received in support of the study and no personal relationships with organizations that could inappropriately influence this work.

References

1. Hoover NW. Methods of lumbar fusion. J Bone Joint Surg [Am]. 1968; 50:194-210.
2. Herkowitz H. Lumbar spine fusions in the treatment of degenerative conditions: current indications and recommendations. J Am Acad Orthop Surg. 1995; 3: 123-35.
3. Henley EN, David SM. Current concept review– Lumbar arthrodesis for the treatment of back pain. J Bone Joint Surg Am. 1999; 81:716-30.
4. Brodsky AE, Kovalsky ES, Khalil MA. Correlation of radiologic assessment of lumbar spine fusions with surgical exploration. Spine. 1991; 16(6 Suppl):S261-5.
5. Blumenthal SL, Gill K. Can lumbar spine radiographs accurately determine fusion in postoperative patients? Correlation of routine radiographs with a second surgical look at lumbar fusions. Spine. 1993; 18: 1186-9.
6. Kant AP, Daum WJ, Dean SM, Uchida T. Evaluation of lumbar spine fusion. Plain radiographs versus direct surgical exploration and observation. Spine. 1995; 20:2313-27.
7. Chafetz N, Cann CE, Morris JM, Steinbach LS, Goldberg HI, Ax L. Pseudarthrosis following lumbar fusion: detection by direct coronal CT scanning. Radiology. 1987; 162:803-5.
8. Rothman SLG, Glenn WV Jr. CT evaluation of interbody fusion. Clin Orthop Rel Res. 1985; 193: 47-56.
9. Fritzell P, Hagg O, Wessberg P, Nordwall A; Swedish Lumbar Spine Study Group. Volvo award winner in clinical studies: lumbar fusion versus nonsurgical treatment for chronic low back pain: a multicenter randomized controlled trial from the Swedish Lumbar Spine Study Group. Spine. 2001; 26:2521-32.
10. Fritzell P, Hagg O, Wessberg P, Nordwall A; Swedish Lumbar Spine Study Group.. Chronic low back pain and fusion: A comparison of three surgical techniques– A prospective multicenter randomized study from the Swedish lumbar spine study group. Spine. 2002; 27:1131-41.
11. Stauffer RN, Coventry MB. Posterolateral lumbar spine fusion. J Bone Joint Surg [Am]. 1972; 54: 1195-204.
12. Agazzi S, Reverdin A, May D. Posterior lumbar interbody fusion with cages: an independent review of 71 cases. J Neurosurg. 1999; 91:186-92.
13. Brantigan JW, Steffee AD. A carbon fiber implant to aid interbody lumbar fusion. Two-year clinical results in the first 26 patients. Spine. 1993; 18:2106-7.
14. Lidar Z, Beaumont A, Lifshutz J, Maiman DJ: Clinical and radiological relationship between posterior lumbar interbody fusion and posterolateral lumbar fusion. Surg Neurol. 2005; 64:303-8.
15. Kim KT, Lee SH, et al. Clinical Outcomes of 3 Fusion Methods through the Posterior Approach in the Lumbar Spine. Spine. 2006; 31:1351-7.
16. Lin PM. Posterior lumbar interbody fusion: Complication and pitfall. Clin Orthop Relat Res. 1985; 193:90-102.
17. Deyo RA, Ciol MA, Cherkin DC, Loeser JD, Bigos SJ. Lumbar spinal fusion: a cohort study of complications, reoperations, and resource use in the Medicare population. Spine. 1993; 18:1463-70.
18. Katz JN. Lumbar spinal fusion: surgical rates, costs, and complications. Spine. 1995; 20(24 Suppl):78S-83S.
19. Okuda S,MiyauchiA, Oda T, Haku T, Yamamoto T, Iwasaki M. Surgical complications of posterior lumbar interbody fusionwith total facetectomy in 251 patients. J Neurosurg Spine. 2006; 4:304-9.
20. Lee C. Accelerated degeneration of the segment adjacent to a lumbar fusion. Spine. 1988; 13:375-7.
21. Kumar M, Jacquot F, Hall H. Long-term follow-up of functional outcomes and radiographic changes at

adjacent levels following lumbar spine fusion for degenerative disc disease. Eur Spine J. 2001; 10: 309-13.
22. Hayashi T, Arizono T, Fujimoto T, Moro-oka T, Shida J, Fukumoto S, et al. Degenerative change in the adjacent segments to the fusion site after posterolateral lumbar fusion with pedicle screw instrumentation—a minimum 4-year follow-up. Fukuoka Igaku Zasshi. 2008; 99:107-13.
23. Yang J, Lee J, Song H. The impact of adjacent segment degeneration on the clinical outcome after lumbar spinal fusion. Spine. 2008; 33:503-7.