# Single-level interbody fusion in treatment of lumbar fractures

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**Background**
The purpose of this study was to evaluate the effectiveness of treating lumbar fractures by performing instrumented interbody fusion with the adjacent vertebra.
**Patients**
and methods In a prospective study, 69 consecutive patients with lumbar fractures were treated by single-level interbody fusion. The fractures involving either the superior or inferior endplate with intact pedicles were included.
**Results**
The follow-up period was between 24 and 37 months, with a mean of 28.3 months. The mean preoperative local kyphosis was 10.39° and anterior vertebral height loss was 50.55%. In the final follow-up, they were 2.98° and 16.78%, with a statistically significant difference. On Denis scale for back pain, six patients were P3 with occasional use of medications, and two were P4 with constant use of analgesics at the final follow-up. No case of pesudoarthrosis nor neurologic deterioration was recorded.
**Conclusion**
Single-segment interbody fusion is an effective option in fractures of the lumbar region, involving either endplate, provided the body is not severely comminuted.

**Keywords:**
interbody fusion, lumbar fractures, single-level fixation

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## Introduction

The aims of the treatment in vertebral fractures include providing mechanical stability, restoring and maintaining anatomical alignment, optimizing neurologic recovery, and preventing further damage to the neural elements and early return to work [1].

A consensus on the ideal management of lumbar fractures is yet to be reached. Pedicle screw fixation is the most commonly used. Neural canal decompression, either direct or indirect, is added in patients with neurologic deficits. According to thoracolumbar injury classification and severity score system (TLICS) scale, direct anterior decompression is recommended to remove the retropulsed fragment compressing the thecal sac in burst fractures, especially in those with incomplete spinal cord injuries. The anterior column support also ensures mechanical support and solid fusion [2–4].

In a previous study by our institute, we proposed a monosegmental fixation technique for fractures involving single endplate, either superior or inferior, where only the fractured vertebra and its adjacent one was fixed using pedicle screws [5]. This method aims at sparing a motion segment from being incorporated into the fixation while providing adequate stability and good functional outcome. Interbody fusion was supplemented besides the posterolateral fusion in few cases to provide anterior column support. In this study, we intended to focus only on the cases where interbody fusion was performed, either with or without a cage, to assess the effect of such technique on clinical and radiologic outcome [5].

## Patients and methods

In a prospective study, 69 consecutive patients with lumbar fractures were treated by monosegment posterior interbody fusion. A written consent was obtained from the patients enrolled in the study. The study was approved by Ethical Committee of Ain Shams University after they had signed an informed consent form.

The fractures involving either the superior or inferior endplate with intact pedicles were included in the study. The posterior ligamentous complex was either unaffected or injured as seen on preoperative MRIs. All patients were neurologically free at the time of presentation. Fractures with severe vertebral body comminution or with load sharing score greater than or equal to 7 were excluded [6].



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The mode of trauma, the demographic data, and associated limb fractures were recorded for all patients. Local kyphosis angle and loss of anterior body height were measured on plain radiographs. Computed tomography scans were mandatory to record degree of vertebral body comminution, presence of retropulsed fragments, endplate fractures, and pedicle integrity for pedicle screw insertion. MRI was done to assess posterior ligamentous injury.

With the patient prone on a frame, the fracture level was confirmed using image intensifier before incision. Insertion of the top-loading pedicle screws in the fractured vertebrae is directed toward the inferior in a cephalocaudal trajectory or in line with the superior endplate according to either superior or inferior endplate is fractured, respectively. The vertebrae immediately adjacent to the fractured one sharing the same intervertebral disc with the fractured endplate are also fixed achieving a single-segment fixation.

Following facetectomy and laminectomy, interbody fusion was performed using cancellous morselized local bone from the laminae of the fractured vertebrae with or without a cage providing anterior column support. A morselized bone graft was placed anteriorly to the cages used, as a marker for fusion in the subsequent radiographs. The discs were removed via transforaminal access. The contoured rods are attached to the screws. Correction of local kyphosis and restoration of vertebral body height were checked by the image intensifier. Mean operative time and blood loss were recorded.

Patients were followed up clinically and radiologically. They were followed up for a minimum of 2 years. Local kyphosis angle (as measured as the angle between the intact endplate of the fractured vertebra and that of the adjacent fixed vertebra) and the percentage of anterior vertebral height loss (100 – anterior height of the fractured vertebra divided by the anterior height of the adjacent vertebra fixed multiplied by 100 on lateral view radiographs) were measured on immediately postoperative images and at final follow-up.

Clinically, patients were assessed using Denis back pain scale at the final follow-up [7,8]. Complications were noted. Fusion was assessed using lateral plain radiographs at the final follow-up. Statistical analysis was performed using paired and independent *t*-tests, where *P* less than 0.05 was considered statistically significant.

## Results

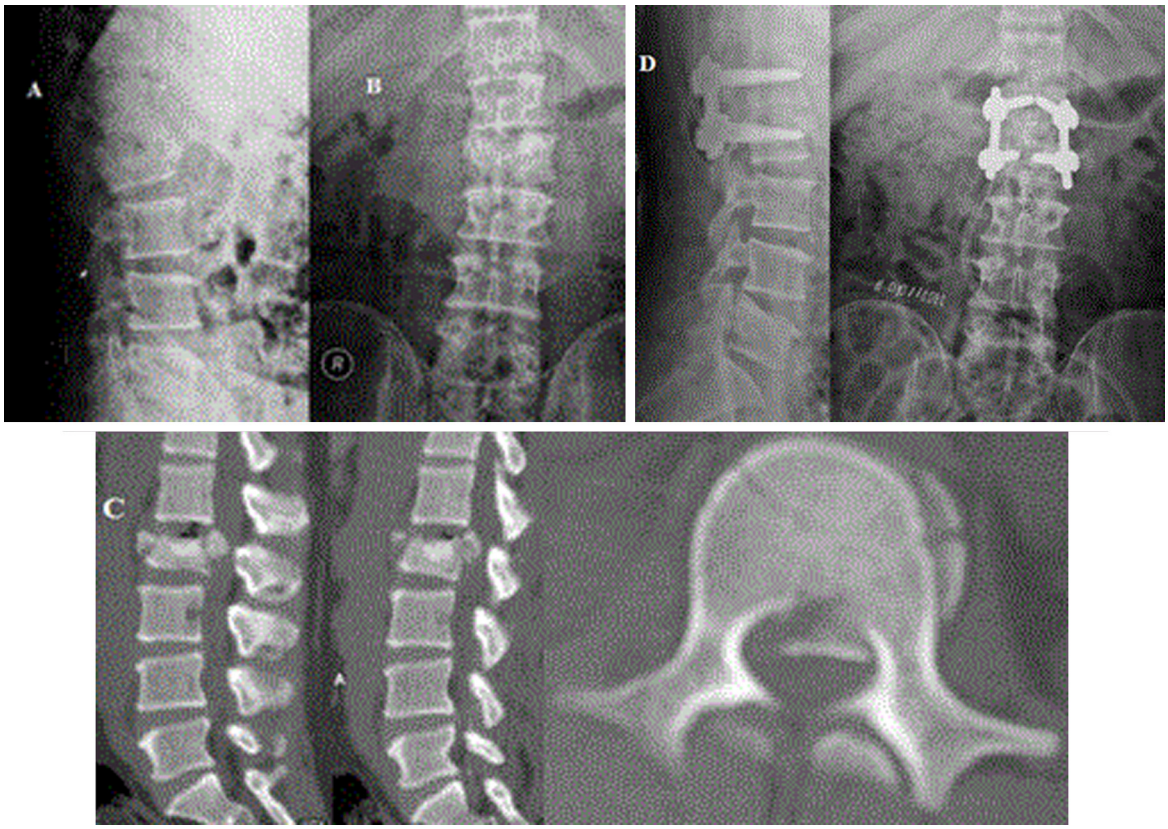
Three patients were lost during the follow-up and were excluded from the study. The mean age of the patients in this study was 28.98 years old (ranging from 17 to 50 years old). The methods of trauma varied from road traffic accidents ($n$=38), falls from height ($n$=20), to sports-related injuries ($n$=8). All patients had compression element to their fractures with loss of vertebral body height and fractured endplate, either superior or inferior. A total of 22 patients showed retropulsed fragments. Six patients had ruptured posterior ligaments in between the adjoining vertebrae. A total of 46 patients had fractures in the upper lumbar region (L1-L2) and 20 patients in the lower lumbar region (L3-L5). None of the patients had noncontiguous vertebral fractures and 12 had associated limb fractures. The mean operative time was 94 min, with a mean blood loss of 310 ml (Figs. 1 and 2). The mean follow-up period was 28.3 months (24–37 months).

The mean preopertative local kyphotic angle and loss of vertebral height were 10.39° and 50.55%, respectively. These improved significantly to 2.07° and 15.98% at the immediate follow-up ($P<0.05$). At the final follow-up, the mean angle was 2.98°, with the loss in correction being statistically insignificant. The mean loss of vertebral height was 16.78%, with the loss also being insignificant. The final values showed statistically significant improvement to the preoperative ones ($P<0.05$). Plain radiographs showed solid fusion in 50 cases at the final follow-up. Solid radiologic evidence of fusion with traversing bone trabeculae across the disc space could not be confirmed in the rest; however, no implant failure was recorded at the final follow-up.

Regarding back pain, the Denis scale at the final follow-up showed 40 patients with no pain (P1), 18 patients with minimal pain with no need for medications (P2), six patients with moderate pain with occasional use of medications (P3), and two patients with moderate to severe pain with constant use of medications (P4), and none had severe pain with chronic use of medications (P5). The pain and the need for medications were noted more in patients who experienced associated multiple fractures.

One patient experienced immediate postoperative foot drop (2/5) following L4/L5 fusion. The weakness resolved completely within 3 months. Superficial wound infection was noted in three patients, which was treated successfully with antibiotics. Dural tears, which were immediately sutured, occurred in three

**Figure 1**




(a) Lateral and (b) anteroposterior plain radiographs of a 19-year-old female patient experiencing L2 fracture involving the superior endplate following fall from height. (c) Computed tomography showing retropulsed fragment and intact pedicles. (d) Postoperative plain radiographs where single-level fixation and interbody fusion with local bone was performed.

patients during the procedure, but there was no leukorrhea postoperatively. Six cases showed embedding of the interbody cage into the fractured endplate at the final follow-up. However, the loss in kyphosis correction was insignificant, and the segment was fused in all cases (Fig. 3). Clinical and demographic data are summarized in Table 1.

## Discussion

Thoracolumbar or lumbar fractures with mechanical compromise can significantly affect the patients' quality of life if not properly managed, especially that these fractures are most common in the active population [9,10].

No solid consensus has been reached about the optimum treatment for these injuries, with both surgery and conservative methods been advocated [1]. Without surgery, the prolonged bed rest or postural reduction and stabilization in some form of orthoses could be quite inconvenient for the patients. Rehabilitation and return to work could also be delayed. Furthermore, in cases where neurologic deficits are found, some form of decompression is preferred by many, assuming to provide best chance of recovery for the patients. Comparative studies have shown surgery to be superior to nonsurgical treatment regarding neurologic recovery, early mobilization, and reduction in complications [3,11].

In cases with severe comminution of the vertebral body, short-segment posterior fixation is doomed to failure, owing to screw breakage and collapse. To avoid this, Gaines proposed anterior column reconstruction to be added to short posterior fixation in such cases. As an alternative, long-segment posterior fixation could be performed. However, sacrificing several motion segments is not without its problems [6].

Motion segment preservation is the merit of short-segment fixation. Classically, the vertebra above and the one below the fracture is fixed. Some advocate to place screws in the fractured vertebrae to increase construct stability if the pedicles allow. However, this traditional approach sacrifices two disc spaces. Monosegment fixation spares further vertebra from being incorporated into the fusion construct by fixing only the fractured vertebra and the one above or below it [5,8].

**Figure 2**


(a) Preoperative plain radiograph of a L1 fracture from RTA in a 25-year-old male. (b) Computed tomography showing superior endplate fracture and loss of vertebral height. (c) Postoperative plain radiograph following cage insertion and single-level fusion with the vertebra above. RTA, road traffic accident.

**Figure 3**

A case showing embedding of the cage into the fractured endplate of L1 vertebrae at the final follow-up.

Interbody fusion has been reported to be superior to posterolateral fusion regarding the fusion rate. In degenerative cases, its theoretical advantages include anterior column support of the spine, disc height restoration, and better restoration of vertebral alignment. The removed disc, which is usually degenerated, is a potential source of axial pain. The wide fusion area provided in interbody fusion presumably increases chances of sound fusion [12–15].

Narrowing of the disc spaces has been observed adjacent to the fractured endplates. This has been attributed to the creeping of the disc into the endplate, and this settling contributes to the progressive kyphosis in those treated conservatively [2]. Others report degeneration in such discs, which could be a potential source of back pain. Performing interbody fusion while removing the disc could alleviate such the source of pain and kyphosis. Anterior column support has also been reported to prevent kyphosis, especially in those fractures with loss of vertebral height [16].

Long-segment fixation has been proposed as a risk factor for adjacent segment disease in degenerative

**Table 1 Clinical and demographic data of the patients**

| Case | Sex | Age | Fracture level | Operative time | Blood loss | Preoperative local kyphosis | Postoperative local kyphosis | Final follow-up local kyphosis | Preoperative loss of vertebral height | Postoperative loss of vertebral height |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | M | 23 | L2 | 110 | 330 | 12 | 3 | 4 | 42.2 | 14.3 |
| 2 | M | 35 | L2 | 120 | 400 | 7 | 2 | 2 | 48.4 | 18.8 |
| 3 | M | 25 | L1 | 100 | 350 | 6 | 2 | 2 | 32.3 | 13.4 |
| 4 | M | 27 | L5 | 100 | 300 | 14 | 3 | 5 | 51.8 | 12.5 |
| 5 | F | 24 | L2 | 85 | 300 | 10 | 2 | 4 | 55.5 | 17.3 |
| 6 | M | 20 | L4 | 90 | 350 | 8 | 1 | 2 | 43.8 | 9.7 |
| 7 | M | 29 | L1 | 95 | 400 | 16 | 3 | 5 | 42.6 | 18.2 |
| 8 | F | 28 | L3 | 85 | 320 | 9 | 2 | 2 | 51.3 | 17.3 |
| 9 | M | 34 | L2 | 90 | 330 | 8 | 1 | 2 | 50 | 19.4 |
| 10 | F | 42 | L2 | 85 | 370 | 10 | 3 | 4 | 51.7 | 21.3 |
| 11 | M | 30 | L1 | 100 | 310 | 8 | 2 | 4 | 57.2 | 29.1 |
| 12 | F | 22 | L3 | 85 | 290 | 11 | 1 | 2 | 46.5 | 21.9 |
| 13 | F | 26 | L2 | 90 | 300 | 16 | 1 | 1 | 51.8 | 10 |
| 14 | M | 17 | L3 | 95 | 380 | 7 | 1 | 2 | 52.4 | 15.2 |
| 15 | F | 25 | L1 | 100 | 370 | 9 | 0 | 1 | 50.3 | 10.7 |
| 16 | M | 33 | L3 | 90 | 300 | 10 | 1 | 1 | 50.7 | 18.2 |
| 17 | M | 32 | L2 | 90 | 350 | 12 | 0 | 1 | 53.6 | 17.9 |
| 18 | F | 19 | L4 | 95 | 380 | 13 | 2 | 3 | 55.5 | 18.8 |
| 19 | M | 28 | L1 | 90 | 350 | 10 | 1 | 3 | 58.1 | 14.3 |
| 20 | M | 37 | L2 | 95 | 400 | 9 | 0 | 1 | 51.7 | 14.4 |
| 21 | F | 35 | L1 | 95 | 350 | 16 | 1 | 2 | 54.9 | 19.2 |
| 22 | F | 28 | L2 | 90 | 400 | 15 | 0 | 2 | 51.7 | 12.5 |
| 23 | M | 23 | L3 | 95 | 330 | 8 | 1 | 2 | 51.8 | 16.2 |
| 24 | M | 27 | L3 | 90 | 300 | 9 | 2 | 3 | 46.5 | 14.6 |
| 25 | F | 33 | L1 | 90 | 250 | 7 | 1 | 1 | 43.8 | 17.3 |
| 26 | M | 31 | L2 | 85 | 280 | 13 | 1 | 1 | 48.4 | 12.6 |
| 27 | F | 40 | L3 | 100 | 370 | 8 | 2 | 2 | 51.8 | 12.3 |
| 28 | M | 24 | L1 | 100 | 330 | 16 | 4 | 5 | 55.5 | 12.5 |
| 29 | F | 43 | L4 | 120 | 230 | 11 | 4 | 4 | 43.8 | 16.2 |
| 30 | M | 38 | L1 | 110 | 220 | 7 | 1 | 2 | 38.4 | 18.8 |
| 31 | F | 50 | L3 | 100 | 380 | 12 | 2 | 4 | 57.6 | 9.1 |
| 32 | F | 19 | L2 | 95 | 320 | 15 | 4 | 5 | 51.7 | 19.4 |
| 33 | M | 29 | L1 | 90 | 260 | 9 | 2 | 2 | 53.4 | 16.2 |
| 34 | M | 27 | L3 | 85 | 240 | 10 | 4 | 4 | 46.9 | 20.7 |
| 35 | M | 18 | L2 | 100 | 300 | 11 | 3 | 4 | 51.8 | 21.6 |
| 36 | M | 39 | L1 | 90 | 310 | 8 | 2 | 2 | 54.9 | 18.8 |
| 37 | M | 23 | L3 | 85 | 230 | 8 | 2 | 3 | 53.2 | 16.5 |
| 38 | F | 40 | L1 | 95 | 240 | 7 | 1 | 2 | 51.8 | 10.6 |
| 39 | M | 33 | L3 | 90 | 310 | 8 | 2 | 3 | 48.4 | 14.4 |
| 40 | M | 29 | L2 | 95 | 300 | 9 | 3 | 3 | 51.6 | 15.9 |
| 41 | F | 36 | L1 | 90 | 330 | 9 | 2 | 3 | 51.7 | 14.3 |
| 42 | M | 19 | L2 | 95 | 400 | 10 | 2 | 4 | 56.3 | 17.9 |
| 43 | M | 27 | L2 | 90 | 320 | 13 | 5 | 5 | 56.7 | 12.2 |
| 44 | M | 39 | L1 | 90 | 300 | 12 | 3 | 4 | 51.6 | 14.6 |
| 45 | M | 28 | L2 | 100 | 350 | 10 | 3 | 4 | 51.8 | 22.6 |
| 46 | F | 20 | L2 | 95 | 280 | 9 | 2 | 3 | 51.6 | 13.3 |
| 47 | M | 41 | L1 | 90 | 280 | 7 | 2 | 2 | 46.5 | 19.2 |
| 48 | M | 19 | L3 | 85 | 330 | 16 | 3 | 4 | 53.8 | 20.6 |
| 49 | F | 24 | L1 | 100 | 250 | 11 | 4 | 4 | 57.2 | 9.1 |
| 50 | M | 27 | L2 | 85 | 250 | 8 | 3 | 3 | 50 | 18.8 |
| 51 | M | 39 | L3 | 90 | 280 | 7 | 2 | 2 | 53.6 | 9.7 |
| 52 | F | 18 | L2 | 85 | 220 | 9 | 2 | 3 | 46.9 | 19.1 |
| 53 | M | 28 | L1 | 95 | 250 | 8 | 1 | 2 | 42.2 | 10.7 |
| 54 | M | 37 | L2 | 90 | 280 | 15 | 3 | 5 | 52.4 | 17.9 |
| 55 | M | 32 | L2 | 85 | 300 | 16 | 4 | 5 | 51.8 | 18.8 |

(*Continued*)

**Table1 (*Continued*)**

| Case | Sex | Age | Fracture level | Operative time | Blood loss | Preoperative local kyphosis | Postoperative local kyphosis | Final follow-up local kyphosis | Preoperative loss of vertebral height | Postoperative loss of vertebral height |
|---|---|---|---|---|---|---|---|---|---|---|
| 56 | M | 48 | L1 | 100 | 310 | 7 | 0 | 2 | 50.3 | 19.4 |
| 57 | F | 19 | L3 | 100 | 240 | 11 | 3 | 4 | 51.4 | 13.4 |
| 58 | M | 18 | L2 | 120 | 230 | 16 | 3 | 5 | 56.1 | 21.9 |
| 59 | M | 26 | L2 | 110 | 310 | 8 | 2 | 2 | 42.3 | 12.6 |
| 60 | M | 30 | L2 | 85 | 300 | 13 | 3 | 4 | 40.7 | 15.9 |
| 61 | F | 19 | L1 | 95 | 280 | 10 | 2 | 4 | 57.6 | 19.1 |
| 62 | M | 31 | L3 | 95 | 300 | 14 | 3 | 5 | 51.7 | 10.6 |
| 63 | F | 21 | L2 | 90 | 350 | 6 | 1 | 2 | 53.4 | 14.6 |
| 64 | F | 28 | L3 | 90 | 250 | 7 | 0 | 2 | 46.9 | 12.6 |
| 65 | M | 22 | L2 | 100 | 320 | 12 | 3 | 4 | 51.8 | 13.3 |
| 66 | M | 32 | L2 | 90 | 320 | 10 | 3 | 3 | 54.9 | 14.6 |

F, female; M, male.

cases [17]. Sparing motion segments by monosegment fusion could presumably decrease such risk. However, such assumption requires longer periods of follow-up to be confirmed.Regarding neurologic deficit, in burst fractures, the retropulsed fragment damaging the nerve is usually trapped at the level of the pedicles of the fractured vertebra. This fragment is usually reduced by ligamentotaxis via screw distraction, thus performing indirect decompression, or directly accessed via anterior approach while performing corpectomy. Various studies have reported on the contribution of such approaches to the neurologic recovery [18,19]. Presumably during the monosegment fusion technique, such fragment may be approached transforaminally following unilateral facetectomy, and either hammered back into the body or removed if feasible and not traumatizing to the dural sac, especially in the levels below the cord. However, such approach is not applicable if the fractured vertebrae is severely comminuted, not allowing proper screw purchase.

## Conclusion

Single-segment interbody fusion is an effective option in fractures of the lumbar region, involving either endplate, provided the body is not severely comminuted. It provides sparing of a motion segment while allowing early mobilization and adequate fixation. It allows preservation of disc space height and anterior column support. Presumably, the laminectomy may contribute to neurologic recovery. In further studies, we intend to perform this surgery on patients with posttraumatic neural deficits.

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**Conflicts of interest**

There are no conflicts of interest.

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