

load-sharing

Decision of Posterior Fixation Level by Load-Sharing Classification in Thoracolumbar and Lumbar Burst Fracture

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– Abstract –

Study Design : Retrospective study on 54 thoracolumbar and lumbar burst fractures treated with pedicle screw instrumentation.

Objectives : To decide the optimal level of fusion in thoracolumbar and lumbar burst fractures treated with pedicle screw instrumentation by load sharing concept.

Summary of Literature Review : Short segment pedicle screw fixation is condemned with frequent failure in maintenance of reduction. The type of posterior fixation construct that is most desirable is less well defined.

Materials and Methods : Using the Load-Sharing classification, Group I consisted of 24 cases with fractures totaling 6 points or less underwent surgery which was subdivided into two subgroups(A : 1 level above and below including fractured vertebra, B : long segment fixation). Group II consisted of 30 cases with fractures totaling 7 points or more underwent surgery which was subdivided into three subgroups(C : 1 level above and below including fractured vertebra, D : 2 levels above, 1 level below including fractured vertebra, E : 2 levels above and below the fractured vertebra). Change of segmental kyphosis, inter-screw angle, upper disc height, lower disc height and anterior body height were measured using post-operative and follow-up lateral radiographs.

Results : Comparing two subgroups in group I(A Vs. B), group A showed definitely more loss of upper disc height than group B but the others were not significantly different. Comparing three subgroups in group II(C, D, E), group C showed definitely more loss of reduction than two other groups but loss of anterior body height was not significantly different. There were no significant differences between group D and E.

Conclusions : For fracture totaling 6 points or less, the long segment fixation(2 level above and 1 level below including fractured vertebra) is a successful method at thoracolumbar junction and short segment fixation to preserve motion segment at lumbar spine. For fracture totaling 7 points or more, short segment fixation is inappropriate and long segment pedicle screw fixation (2 level above and 1 level below including fractured vertebra) could effectively treat burst fractures of thoracolumbar and lumbar spine.

Key Words : Thoracolumbar, Lumbar, Burst Fracture, Posterior Fixation and Fusion level

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가 17 (31.5%), 3
 (5.5%) . 1 가 21 (38.9%) 가
 , 12 2 가 10 (18.5%),
 3 가 8 (14.8%), 4 가 4 (7.4%), 11 가
 1 (1.9%) .

가 , 50%
 , 20 , 50%
 가 , 1

(TLSO)

3

가 가 54 load-sharing 6 “I”
 (Table 2), 7 “II” (Table 3) ,
 “I” ()
 1 A (Fig. 1), ()
 2 , 1

(scoring)

McCormack ⁸⁾ load-sharing (Table) B 2 .

1)

가 “II” C (Fig. 2), 2

load-sharing , 1 D (Fig. 3), 2

E .

가

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 1

, 1 가 54 가

21 , 16 67 36 , .
 12 67 31.6

가 34 (63%), 가 .

Table 1. The load shearing classification of spine fractures

| Score | Comminution /Involvement (%) | Apposition of fracture fragments (mm) | Deformity correction (degree) |
|-------|------------------------------|---------------------------------------|-------------------------------|
| 1 | < 30(little) | < 1(minimal) | < 3(little) |
| 2 | 30 to 60(more) | 1 to 2(spread) | 4 to 9(more) |
| 3 | > 60(gross) | > 2(wide) | > 10(most) |

Table 2. Patients with fracture totaling 6 points or less (Group A, B)

| Case | Sex /Age (yrs) | Group | Level of injury | Cause of injury | Load-sharing score | Duration of F/U (mos.) | Loss of kyphotic correction (degree) F/U-Postop. | Loss of interscrew angle(degree) F/U-Postop. | Loss of upper disc height (%) Postop.-F/U | Loss of lower disc height (%) Postop.-F/U | Loss of ant. vertebral height (%) Postop.-F/U |
|------|----------------|-------|-----------------|-----------------|--------------------|------------------------|--|--|---|---|---|
| 1 | M/40 | A | L2 | Others | 5 | 13 | 7.4 | 4.6 | 13.8 | 12.2 | 4 |
| 2 | F/24 | A | L3 | Fall | 6 | 21 | 4 | 2.7 | 22.5 | 13.5 | 2.1 |
| 3 | M/44 | A | L4 | Fall | 6 | 20 | 8.7 | 2 | 39.9 | 23.8 | 5.1 |
| 4 | M/24 | A | L3 | MVA | 5 | 27 | 4.8 | 5.6 | 24.7 | 26.9 | -2.3 |
| 5 | M/32 | A | L2 | Fall | 5 | 29 | 3 | -0.7 | 28.7 | 16.3 | 4 |
| 6 | M/29 | A | L2 | Fall | 4 | 32 | 0.1 | 5.6 | 9.2 | 15.1 | 2.5 |
| 7 | F/38 | A | L2 | MVA | 5 | 38 | 7 | 2.8 | 24.4 | 10.3 | -2.9 |
| 8 | F/19 | A | L1 | Fall | 6 | 12 | 3.9 | 2.7 | 10 | 16.4 | 11.4 |
| 9 | M/41 | A | L1 | Fall | 5 | 15 | 6.5 | 7.1 | 40.3 | 37.2 | 3.9 |
| 10 | M/19 | A | L1 | Fall | 4 | 17 | 4.7 | 0.6 | 21.5 | 28.9 | 7.5 |
| 11 | F/41 | A | L4 | Fall | 4 | 53 | 9.5 | 4.7 | 16.5 | 3.1 | 8.4 |
| 12 | M/49 | A | L1 | Fall | 4 | 52 | 12.9 | 3.5 | 37.5 | 9.9 | 7.9 |
| 13 | M/35 | A | L3 | Fall | 3 | 48 | 4.3 | -0.3 | 27.3 | 9 | 3.8 |
| 14 | F/51 | A | L2 | Fall | 5 | 43 | 7.3 | 3.9 | 14.6 | 41.9 | 0.4 |
| 15 | F/29 | A | L2 | MVA | 4 | 39 | 2.6 | 4 | 3.2 | 14.4 | 0.3 |
| 16 | M/43 | A | L4 | MVA | 5 | 38 | 6.7 | 5 | 21.4 | 16.9 | 0.6 |
| 17 | F/19 | B | L1 | Fall | 5 | 36 | 5.2 | 5 | 8.8 | 19.4 | 3.3 |
| 18 | M/23 | B | L1 | Others | 5 | 26 | 6.2 | 3.9 | 8.9 | 21.7 | 2.6 |
| 19 | F/30 | B | L1 | Fall | 4 | 35 | 5.8 | 3.3 | 34.8 | 8.2 | -2.3 |
| 20 | F/34 | B | L1 | MVA | 5 | 39 | 1.7 | 0.9 | 10.1 | 14.6 | -2.9 |
| 21 | F/62 | B | T12 | MVA | 6 | 22 | 6.3 | 5.8 | 11.4 | 16.5 | 2 |
| 22 | M/52 | B | T12 | MVA | 4 | 26 | 4.9 | -0.8 | 4.3 | 17.9 | 2.6 |
| 23 | M/38 | B | L1 | Others | 4 | 30 | 6 | 2 | 7.1 | 33.3 | -0.6 |
| 24 | F/48 | B | T12 | Fall | 5 | 43 | 3.9 | 0.7 | 2.7 | 12.1 | 3.3 |

ys : years F/U : follow-up mos : months Preop. : preoperation Postop. : postoperation F : female M : male

MVA : motor vehicle accident Others : struck by a heavy object

Table 3. Patients with fracture totaling 7 points or more (Group C, D, E)

| Case | Sex /Age (yrs) | Group | Level of injury | Cause of injury | Load-sharing score | Duration of F/U (mos.) | Loss of kyphotic correction (degree) F/U-Postop. | Loss of interscrew angle (degree) F/U-Postop. | Loss of upper disc height (%) Postop.- | Loss of lower disc height (%) Postop.- | Loss of ant. vertebral height (%) Postop.-F/U |
|------|----------------|-------|-----------------|-----------------|--------------------|------------------------|--|---|--|--|---|
| 25 | M/54 | C | L2 | Fall | 8 | 55 | 5.2 | 5.6 | 35 | 31.3 | -1.5 |
| 26 | M/31 | C | L3 | Fall | 7 | 37 | 17.2 | 14.9 | 44.5 | 42.7 | 15.4 |
| 27 | F/54 | C | L3 | Fall | 7 | 14 | 5.5 | 6.7 | 23.9 | 24.2 | 5.6 |
| 28 | F/40 | C | L3 | Fall | 8 | 27 | 7.5 | 6.8 | 11.5 | 22.8 | 10.7 |
| 29 | M/16 | C | L4 | Fall | 7 | 51 | 14 | 4.1 | 25 | 18.3 | 9.2 |
| 30 | M/31 | C | L1 | Fall | 7 | 14 | 5.1 | 7.5 | 29.7 | 14.5 | 2.4 |
| 31 | M/42 | C | L1 | Fall | 9 | 15 | 4.1 | 8.3 | 18 | 28.4 | 2.4 |
| 32 | M/33 | C | L2 | Fall | 7 | 13 | 8.2 | 8 | 30.8 | 22.9 | 8.9 |
| 33 | M/41 | C | L1 | Fall | 7 | 25 | 0.3 | 1.2 | 7.9 | 12.8 | 0.3 |
| 34 | F/35 | C | L3 | MVA | 8 | 31 | 12.7 | 10 | 34.8 | 17.8 | 8.8 |
| 35 | M/32 | C | L1 | Fall | 9 | 36 | 1.1 | 4.2 | 27.4 | 15.2 | 10.7 |
| 36 | F/19 | D | L1 | Fall | 8 | 13 | 2.4 | 0.2 | 4 | 9.7 | 1 |
| 37 | M/38 | D | L2 | Fall | 7 | 39 | 5 | 5 | 18.3 | 18.8 | 9.2 |
| 38 | M/24 | D | T12 | Fall | 8 | 37 | 1.1 | 6.5 | 24.6 | 14.1 | 12.2 |
| 39 | M/42 | D | L1 | MVA | 7 | 32 | 3.9 | 6.9 | 13.3 | 2.3 | 6.5 |
| 40 | M/37 | D | T12 | Fall | 7 | 30 | 2.5 | 4 | 18.5 | 17.9 | 3.7 |
| 41 | M/25 | D | L2 | Fall | 7 | 29 | 0.3 | 0.1 | 14.8 | 4.1 | 5.3 |
| 42 | M/26 | D | L3 | Fall | 8 | 18 | 3.2 | 4.5 | 16.4 | 16.1 | 5.5 |
| 43 | M/28 | D | L1 | MVA | 7 | 46 | 4.4 | 2.2 | 12.7 | 17.1 | 3.7 |
| 44 | M/26 | E | L1 | MVA | 8 | 19 | 6.5 | 8.3 | 31.5 | 34.2 | 16.5 |
| 45 | M/36 | E | T12 | Fall | 8 | 67 | 4.9 | 4.8 | 17.7 | 10.6 | 5.4 |
| 46 | F/32 | E | T12 | MVA | 8 | 39 | 0.9 | 4.8 | 11 | 6.5 | 5.1 |
| 47 | F/21 | E | L1 | MVA | 8 | 38 | 6.5 | 3.8 | 3.8 | 4.3 | 11.4 |
| 48 | F/37 | E | L1 | MVA | 7 | 35 | 1.8 | 1.5 | 11.5 | 19.5 | 4.2 |
| 49 | F/36 | E | L1 | Fall | 9 | 31 | 4.7 | 0.6 | 10.9 | 14.1 | 6.7 |
| 50 | M/58 | E | T12 | MVA | 8 | 13 | 5.4 | 3.8 | 13.6 | 15.7 | 3.1 |
| 51 | M/33 | E | T12 | Fall | 7 | 45 | 4.7 | 2.8 | 19.5 | 15.2 | 1.7 |
| 52 | F/52 | E | L1 | MVA | 8 | 29 | 3.8 | 2.3 | 9.6 | 7.1 | 7.4 |
| 53 | F/67 | E | T12 | Fall | 8 | 25 | 2.7 | 3.2 | 9.3 | 10.4 | 13.7 |
| 54 | M/26 | E | T11 | MVA | 8 | 49 | 2.4 | 3.9 | 18.7 | 13.2 | 4.2 |

ys : years F/U : follow-up mos : months Preop. : preoperation Postop. : postoperation F : female M : male
MVA : motor vehicle accident

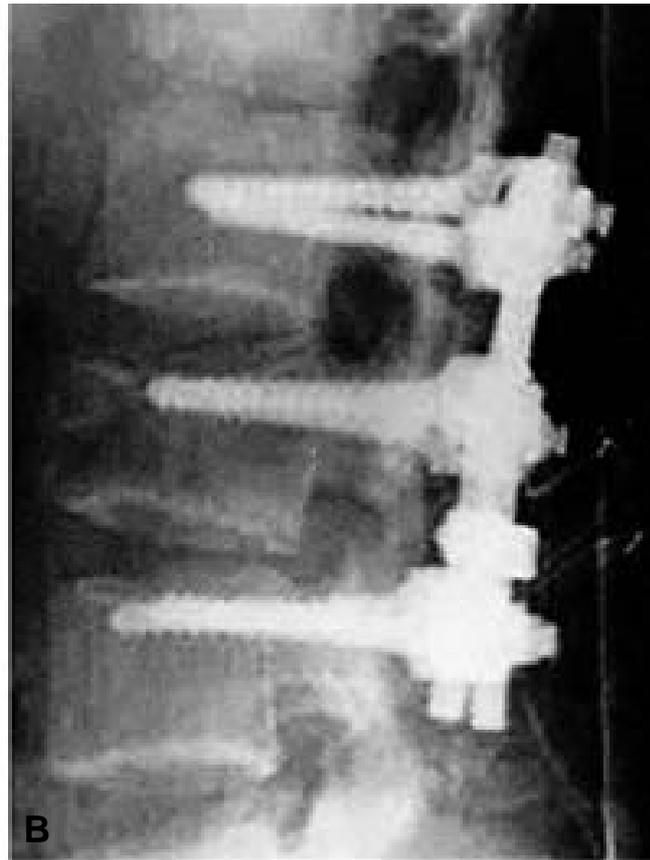


Fig. 1. Group A (case No. 4)

- A.** 24-year-old man was injured by MVA sustaining L3 burst fracture. The point total is 5 points.
- B.** Short segment transpedicular fixation was done from L2 to L4.
- C.** At 27 months of follow-up, 25% loss of upper disc height is noted.

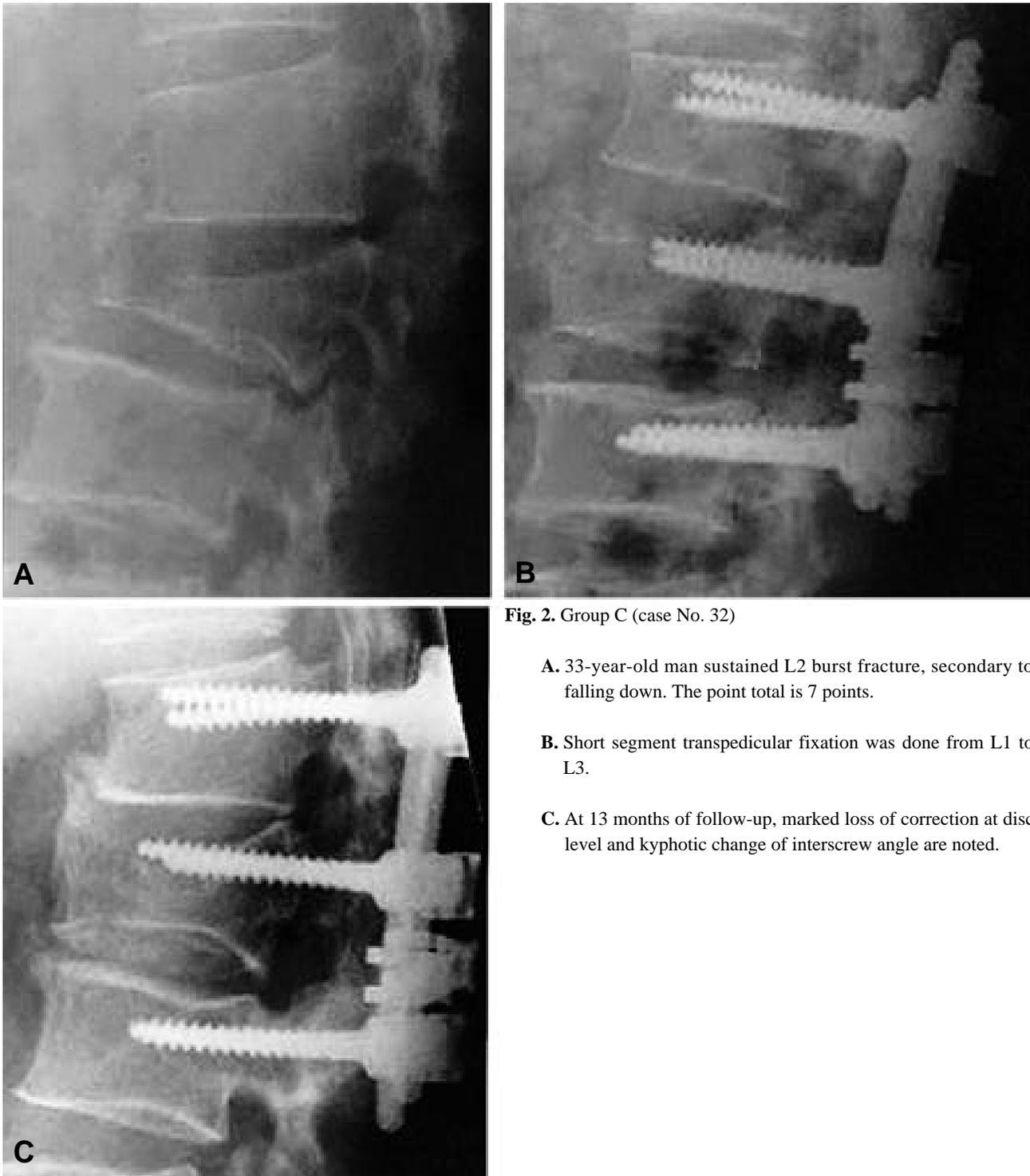


Fig. 2. Group C (case No. 32)

- A.** 33-year-old man sustained L2 burst fracture, secondary to falling down. The point total is 7 points.
- B.** Short segment transpedicular fixation was done from L1 to L3.
- C.** At 13 months of follow-up, marked loss of correction at disc level and kyphotic change of interscrew angle are noted.

가 load-sharing (B) 가 (A) 가 . test C,D,E , load-sharing 가 7 ANOVA test . One-way Student t-

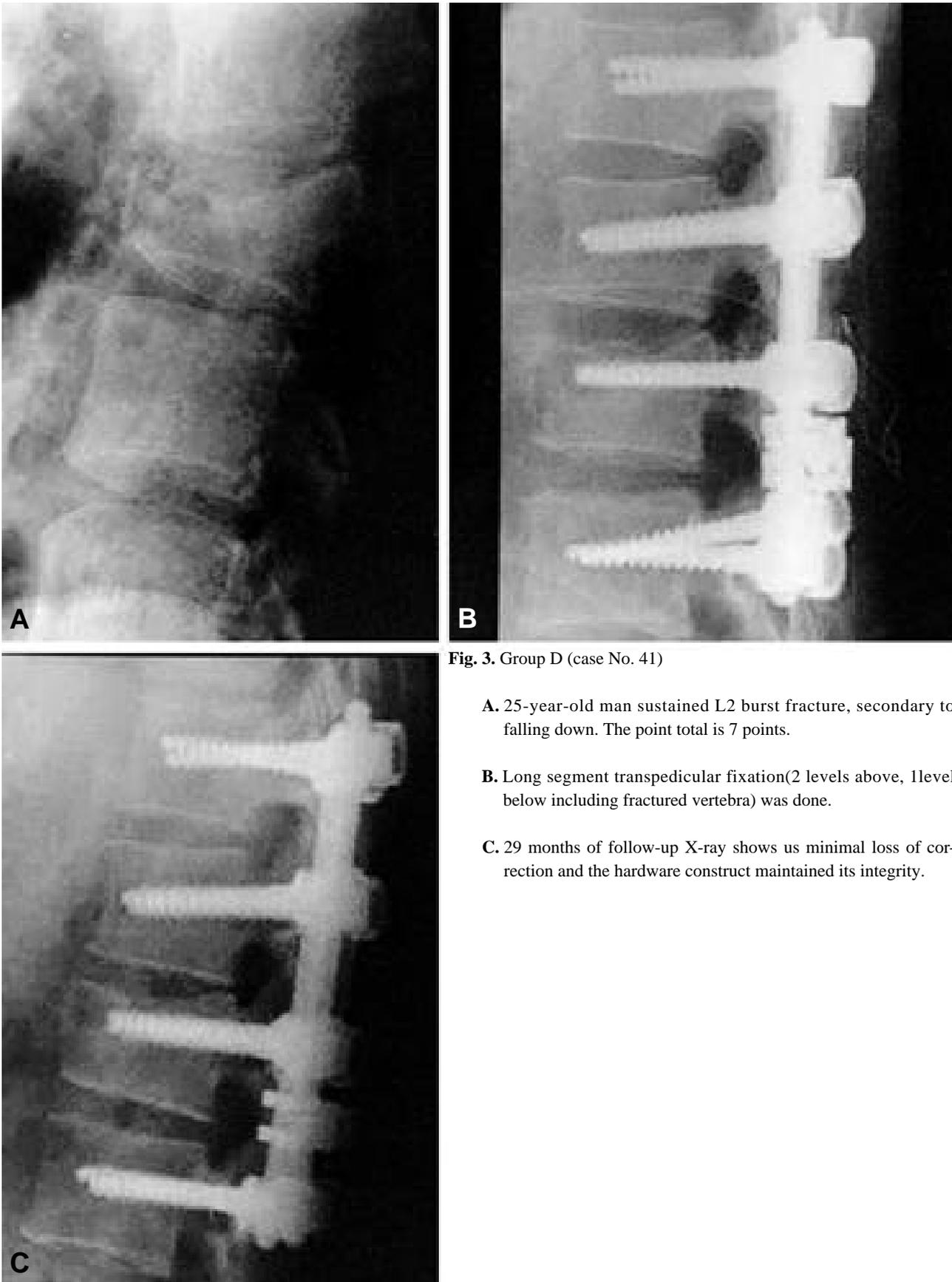


Fig. 3. Group D (case No. 41)

- A.** 25-year-old man sustained L2 burst fracture, secondary to falling down. The point total is 7 points.
- B.** Long segment transpedicular fixation(2 levels above, 1level below including fractured vertebra) was done.
- C.** 29 months of follow-up X-ray shows us minimal loss of correction and the hardware construct maintained its integrity.

3) 18.5%

1. load-sharing (Table 4) 6 A B 18.0% (p=0.902).

1) 22.2% 11.0% (p=0.024).

5.0% (p=0.479).

4) 3.5% 1.0% (p=0.112).

2) 3.4%

2. load-sharing (Table 5) 7 C,D,E

2.6% (p=0.435).

1) C 7.4% 가 (p=0.011), D,E

Table 4. Comparison of two groups with fracture totaling 6 points or less

| | No. of cases | Loss of segmental kyphosis correction(°) | Loss of interscrew angle(°) | Loss of upper disc height(%) | Loss of lower disc height(%) | Loss of anterior vertebral height(%) |
|---------|--------------|--|-------------------------------|------------------------------|------------------------------|--------------------------------------|
| A | 16 | 5.84 ± 3.08 | 3.36 ± 2.18 | 22.22 ± 10.94 | 18.49 ± 10.58 | 3.54 ± 3.92 |
| B | 8 | 5.00 ± 1.55 | 2.60 ± 2.29 | 11.01 ± 10.04 | 17.96 ± 7.51 | 1.00 ± 2.55 |
| P value | | 0.479 | 0.435 | 0.024* | 0.902 | 0.112 |

A : 1 level above, 1 level below including fractured vertebra B : long segment fixation
 * : significant differences(p<0.05)

Table 5. Comparison of three groups with fracture totaling 7 points or more

| | No. of cases | Loss of segmental kyphosis correction(°) | Loss of interscrew angle(°) | Loss of upper disc height(%) | Loss of lower disc height(%) | Loss of anterior vertebral height(%) |
|---|--------------|--|-------------------------------|------------------------------|------------------------------|--------------------------------------|
| C | 11 | 7.35 ± 5.32 | 7.02 ± 3.55 | 26.22 ± 10.70 | 22.81 ± 8.79 | 6.63 ± 5.19 |
| D | 8 | 2.85 ± 1.61* | 3.68 ± 2.62* | 15.32 ± 5.92* | 12.51 ± 6.41* | 5.89 ± 3.49 |
| E | 11 | 4.03 ± 1.87* | 3.62 ± 2.03* | 14.28 ± 7.36* | 13.71 ± 8.15* | 7.22 ± 4.68 |

C : 1 level above, 1 level below including fractured vertebra
 D : 2 levels above, 1 level below including fractured vertebra
 E : 2 levels above and below the fractured vertebra
 * : significant differences(p<0.05)

0.036). D,E (p=0.48). 가 2,7,16,17).

2) 가 15).
가

C ,
7.0. 가 , D,
E (p=0.017, 0.009). 가 가
D, E (p=0.97).
C 5
(case No. 26, 30, 31, 32, 34), E 1 (case No. 44)
, D 5,9,15).

3) 1994 McCormack 8)
(load sharing
capacity) 가가
가
C
26.2% 가 D, E
15.3%, 14.3% C
(p=0.010, 0.003). D,E
(p=0.793). C
22.8%
가 D,E 12.5%, 13.7%
C (p=0.010,
0.013). D,E (p=0.750). 9 7

4) McLain 9) 2
C 6.6%
D, E 5.9%, 7.2% . C, 19 6 3
D,E 1 10
McNamara 10)
8.7%
3 가 84%
, 가
가 4,14,18).
1
54 McCormack 8)
load-sharing
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2
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Pool Gaines¹³⁾ 가 가

445N(100lb) 가

11.5 Nm 가 ,

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6 (6 가

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B , load-sharing 7

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A B 22.2% 11.0% 가

(p=0.024). 6 가

Müller ¹¹⁾ Parker ¹²⁾ load-sharing 가 가

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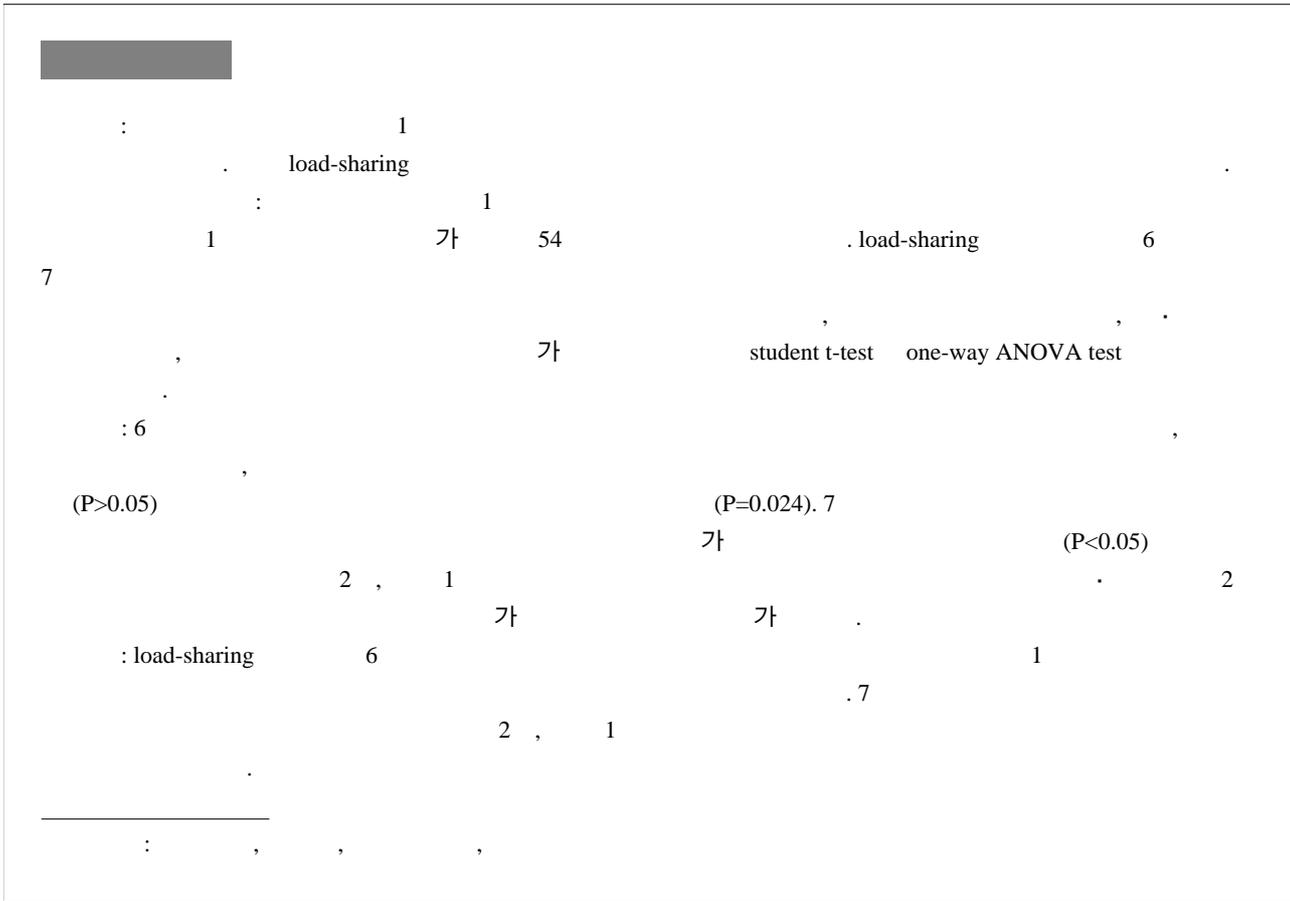
E 가

¹¹⁾ Müller ¹¹⁾ 가가

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