

Subsidence of thoracolumbar burst fractures after rod long/fuse short technique

Can universal instrumentation offer any advantage?

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RESUMO

Achatamento das fraturas tóraco-lombares em explosão após técnica de instrumentação longa e fusão curta. A instrumentação universal pode oferecer alguma vantagem?

Objetivo: Uma das alternativas para o tratamento cirúrgico das fraturas tóraco-lombares em explosão (TLBF) é a técnica de instrumentação longa e fusão curta (RLFS) utilizando o sistema de Harrington. A altura do corpo vertebral fraturado geralmente retorna a valores próximos do normal imediatamente após a cirurgia, mas, alguns meses depois, esse ganho é perdido (achatamento). Nosso objetivo é verificar os resultados clínicos e radiológicos com a técnica RLFS com sistema de instrumentação universal. **Método:** Doze casos de TLBF (masculino/feminino=9/3, média de idade=35,7 anos, Escala de Frankel: E=9, C=3) foram estudados. Através de abordagem posterior, instrumentação universal foi realizada dois níveis acima e dois níveis abaixo da vértebra fraturada. Enxerto ósseo foi colocado de um nível acima a um nível abaixo da fratura. Após pelo menos nove meses, o instrumental localizado além da área enxertada foi removido. Os resultados clínicos foram medidos pela Escala de Frankel e pelo formulário SF-36. Os parâmetros radiológicos (ângulo de Cobb, alturas anterior e posterior da vértebra fraturada) foram medidos em 3 momentos: pré-operatório, pós-operatório imediato e após a remoção do instrumental. Análise estatística foi realizada por análise de variância – ANOVA ($\alpha=0.05$) e teste “t” de Pearson ($p\leq 0.05$). **Resultado:** Não se observou piora neurológica. Todos os pacientes com lesão neurológica, exceto um deles, melhoraram um grau na escala de Frankel. Os parâmetros radiográficos melhoraram após a primeira cirurgia, mas o ganho reduziu após a remoção do material. A cifose pós-operatória interferiu negativamente na qualidade de vida dos pacientes. **Conclusão:** Quando a técnica RLFS é escolhida para tratar uma TLBF, o uso de instrumentação universal não mostra nenhuma vantagem sobre o sistema de Harrington em termos de resultados clínicos e radiológicos.

PALAVRAS-CHAVE

Fratura tóraco-lombar. Instrumentação da coluna. Instrumentação universal.

ABSTRACT

Objective: One alternative for the surgical treatment of thoracolumbar burst fractures (TLBF) is the rod long/fuse short (RLFS) technique utilizing the Harrington Distraction Rods (HDR) system. The height of the fractured vertebral body usually returns to approximately normal values immediately after the surgery, but some months later, this gain is lost (subsidence). Our objective is to verify the clinical and radiological outcome with the RLFS technique with Universal Instrumentation (UI). **Methods:** Twelve cases of TLBF (Male/Female=9/3, mean age=35.7 y.o., Frankel grades: E=9, C=3) were treated. Through a posterior approach, UI was placed two levels above and two below the fractured vertebra. Bone grafts were placed from one level above to one level below the fracture. After at least nine months, the rod was cut and the hardware located beyond the grafted area was removed. Clinical results were measured by Frankel scale and the SF-36 Form. Radiographic parameters (Cobb's angle, anterior and posterior heights of the fractured vertebra) were measured in three moments: pre-operative, immediate post-operative and after hardware removal. Statistical analysis was performed with analysis of variance – ANOVA ($\alpha=0.05$) and Pearson's “t” test ($p\leq 0.05$). **Results:** No neurological deterioration was observed. All neurologically compromised patients, except one, improved one Frankel grade. Radiographic parameters improved after the first surgery, but this improvement was reduced after hardware removal. Post-operative kyphosis negatively interfered in the quality of life of our patients. **Conclusion:** When the RLFS is chosen to treat a TLBF, the utilization of UI does not show advantage over HDR in terms of clinical and radiological outcome.

KEY WORDS

Thoracolumbar fracture. Spinal instrumentation. Universal instrumentation.

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Introduction

Subsidence is the ultimate result of the treatment of thoracolumbar burst fractures by posterior short segment instrumentation, no matter which specific technique is employed^{3,6,19,21,26,27,28,31,33}. Anterior instrumentation seems to solve this problem^{18,4}. Although this approach was associated to increased morbidity some years ago¹², recent experience shows that these surgeries can be safely done^{8,14,24,32}. The need for the participation of another surgical specialist (thoracic surgeon), on the other hand, adds difficulties to, and takes away independence from the spine surgeon. This is true for the operation itself as well as for the post-operative care and for the management of complications.

In this context, it seems desirable to design a surgical technique for posterior short segment instrumentation of thoracolumbar burst fractures capable of preventing subsidence without the aid of another surgical specialist.

According to the AO Manual of Internal Fixation¹, "utilizing an anterior constrained implant device, one level above and below an unstable motion segment, is equivalent in stiffness to a posterior pedicle-screw instrumentation system which spans two levels above and below the motion segment". If this statement is true, subsidence of the fractured body could be prevented by such a posterior instrumentation. Two potential biomechanical advantages can compare Universal Instrumentation favorably to Harrington distraction rods:

1) Universal Instrumentation are constrained implant devices⁷; 2) Universal Instrumentation can be placed in a four point bending mode⁷ while Harrington distraction rods can only be placed in a three point bending mode. The problem with including two levels above and two levels below is the involvement of two additional spine motion units in the construct (long segment fixation).

The idea of rodding long and fusing short has already been tested with the aid of Harrington Distraction Rods (an unconstrained type of instrumentation)¹³. Clinical results were good but subsidence was not avoided. The present authors raised the hypothesis that rodding long and fusing short with Universal Spinal Instrumentation could offer a solution for the dilemma of appropriately treating thoracolumbar burst fractures by the posterior approach.

Patients and methods

The study was performed at Hospital São José do Complexo Hospitalar Santa Casa de Porto Alegre, Rio Grande do Sul, Brazil, during a one year period. All patients harboring a thoracic or lumbar compression fracture class "A2" or "A3" in the Magerl classification²³ between T11 and L3 levels were included. Patients were investigated with X-rays and/or CT scan. Patients with complete spinal cord lesion and patients without clinical conditions to undertake the neurosurgical intervention were excluded. Demographic and clinical data of twelve patients included in this study are presented in Table 1.

Table 1.
Demographic and clinical data

| Case | Sex | Age (years) | Level of fracture | Trauma | Frankel/ ASIA | Time between accident and surgery (days) | Length of first admission (days) | Complications after 1 st surgery | Time between 1 st and 2 nd surgery (months) | Frankel / ASIA after hardware removal | Length of second admission (days) | Complications |
|------|-----|-------------|-------------------|-------------------|---------------|--|----------------------------------|---|---|---------------------------------------|-----------------------------------|---------------|
| 1 | M | 14 | L1 | Fall | E/100 | 7 | 9 | - | 12 | E/100 | 5 | - |
| 2 | F | 62 | L1 | Fall | E/100 | 4 | 10 | - | 9 | E/100 | 5 | - |
| 3 | M | 29 | L1 | Fall | C/70 | 6 | 19 | DVT + UTI | 10 | C/70 | 6 | - |
| 4 | M | 56 | T12 | Fall | E/100 | 10 | 38 | OW Infection | 10 | E/100 | 16 | OW Infection |
| 5 | M | 35 | L1 | Fall | E/100 | 8 | 12 | - | 10 | E/100 | 6 | - |
| 6 | M | 44 | T12 | Car accident | C/87 | 9 | 44 | Pneumonia + UTI | 9 | D/94 | 8 | - |
| 7 | F | 17 | T12 + L1 | Car accident | C/87 | 8 | 17 | - | 9 | E/100 | 5 | - |
| 8 | M | 34 | L2 | Fall | E/100 | 11 | 17 | - | 9 | E/100 | 6 | - |
| 9 | M | 19 | L3 | Run over by a car | E/100 | 11 | 13 | Back pain | 9 | E/100 | 4 | - |
| 10 | F | 22 | T11 | Car accident | E/100 | 2 | 8 | - | 10 | E/100 | 5 | - |
| 11 | M | 47 | T12 | Fall | E/100 | 7 | 5 | Screw fracture | 9 | E/100 | 5 | - |
| 12 | M | 50 | L1 | Fall | E/100 | 6 | 8 | - | 17 | E/100 | 6 | - |

DVT: deep venous thrombosis; UTI: urinary tract infection; OW: operative wound.

Surgical technique

Through a standard posterior approach, Universal Instrumentation System (pedicle screws, pedicular or transverse hooks – manufactured by Equimed®, Indústria de Equipamentos Médicos, Porto Alegre, RS, Brazil) was placed two levels above and two levels below the fractured vertebra. Instrumentation was placed in distraction and lordosis (four point bending). Bone grafts from the iliac crest were placed from one level above to one level below the fracture (Figure 1). After at least nine months, a new surgery was performed. The maneuver cited by Dekutoski¹³ was performed in order to check the formation of a solid bone fusion mass. The rod was cut at the end of the arthrodesis and the hardware located beyond the grafted area was removed (Figure 2).

Clinical and radiological evaluation

Neurological evaluation of the surgical results was performed by the Frankel scale¹⁵. The SF-36 Form¹¹ was used to evaluate the quality of life after the removal of the hardware.

The imaging evaluation consisted in plain X-rays and CT scan. One exam (either CT or lateral X-ray) of good quality was chosen to represent each one of the

three moments: pre-operative (B), post-operative of the first surgery (PO) and post-operative of the second surgery (PR). All images were analyzed after digitalization in the AutoCAD[®] software⁵. The following radiographic parameters were measured: Cobb's angle, anterior and posterior heights of the fractured vertebra. For statistical purposes, the posterior height of the first vertebral body located above the fractured vertebra was considered as 1.00. Measurements were performed in the three different moments (B, PO and PR).

Statistical analysis

Data concerning fractured body anterior and posterior heights, and Cobb's angles were described with the aid of Box Plot Graphics showing the distribution of elements in the three different moments of the study: B, PO and PR.

Statistical comparison among the three moments was performed with analysis of variance (ANOVA) for repetitive measures. The level of significance was $\alpha = 0.05$. The correlation between physical score and kyphotic deformity was measured by Pearson's "r" test. The threshold of significance was represented by $p = 0.05$. Data were processed and analyzed with the program SPSS V.11.0[®] (SPSS, Inc., Chicago, IL)¹⁷.

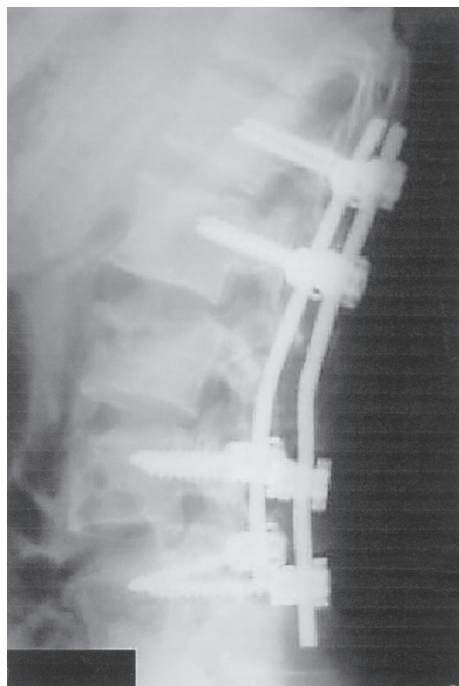


Figure 1 – Immediate post-operative X-ray.

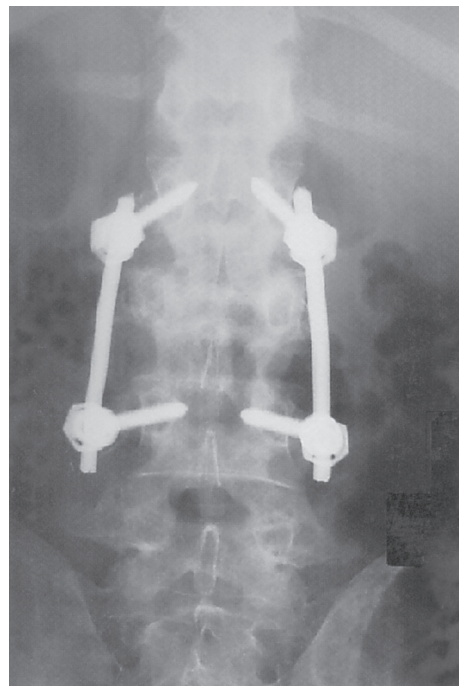


Figure 2 – X-ray after hardware removal.

Results

Clinical results

After the last clinical examination, no neurological deterioration was observed. All neurologically compromised patients, except patient 3, improved one Frankel grade (Table 1).

During the second operation all patients presented a solid bone fusion mass encompassing the levels previously grafted.

The results of calculated data of the SF-36 test are shown in Table 2. Physical score was calculated by adding the mean values of functional capacity, physical aspects, pain and general state of health and dividing this sum by four. The mean physical score at the end of treatment was 64.21 (standard deviation = 28.03). Mental score was calculated by adding the mean values of vitality, social aspects, emotional aspects and mental health and dividing this sum by four. The mean mental score was 65.66 (standard deviation = 20.85).

The association between physical score and kyphotic deformity was studied by dividing the patients in two different groups: A - patients with final physical score higher than the average (cases 1, 2, 3, 7, 8, 9); B - patients with final physical score lower than the average (cases 4, 5, 6, 10, 11, 12). The mean final kyphosis was higher in group B (mean = 12.87°; standard deviation = 5.80) than in group A (mean = 3.32°; standard deviation = 9.13). The correlation between physical score and kyphotic deformity was measured by Pearson's "r" test. There was significant inverse correlation between these two variables ($p = 0.0313$).

Radiological results

Analysis of the variations of Cobb's angle and vertebral body heights in the three moments are presented in Figures 3, 4 and 5.

The mean preoperative Cobb's angle was 10.96° (standard deviation = 6.23). After the first surgery the mean Cobb's angle decreased to 2.42° (standard deviation = 9.86) and after hardware removal this angle returned to 8.09° (standard deviation = 8.83). There was

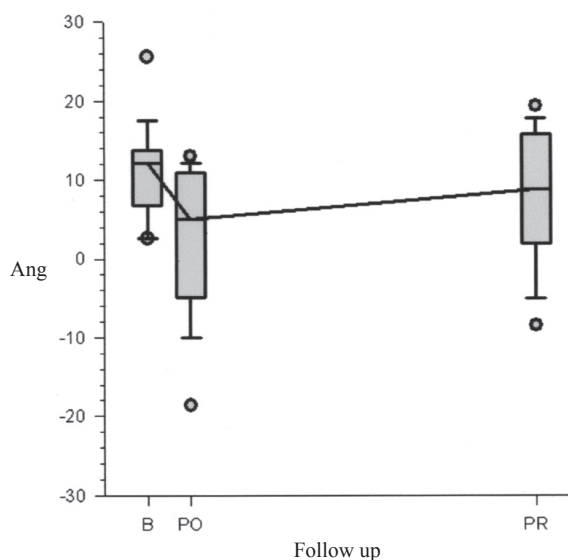


Figure 3 – Cobb's angle in degrees (Ang) in three moments: B (pre-operative) mean = 10.96, standard deviation = 6.23; PO (immediate post-operative) mean = 2.42, standard deviation = 9.86; PR (after hardware removal) mean = 8.09, standard deviation = 8.83. There was significant difference between B and PO: ANOVA, $\alpha = 0.015$.

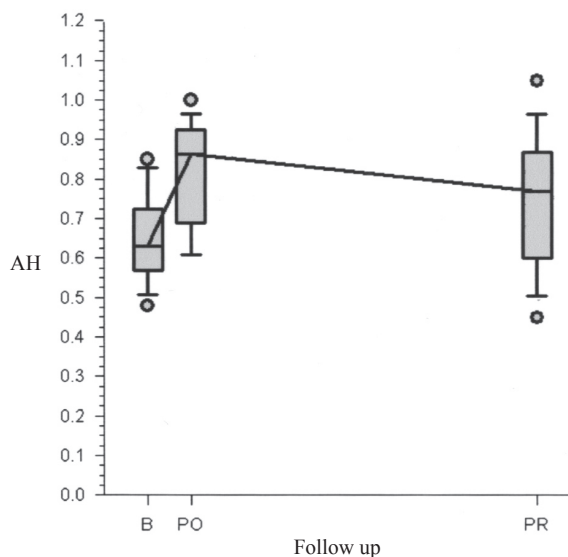


Figure 4 – Anterior height of the fractured vertebra (AH). Values are presented as percentage of the posterior height of the vertebral body immediately above the fracture in three moments: B (pre-operative) mean = 0.65, standard deviation = 0.11; PO (immediate post-operative) mean = 0.82, standard deviation = 0.13; PR (after hardware removal) mean = 0.73, standard deviation = 0.17. There was significant difference between B and PO: ANOVA, $\alpha = 0.005$.

Table 2.
Calculated Scores for SF-36 Quality of Life Form

| SF-36 | Patient | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Mean | Standard deviation |
|----------------|---------|----|------|------|------|------|------|------|------|------|----|------|------|-------|--------------------|
| Physical Score | | 70 | 85.2 | 97.5 | 56.5 | 5 | 34.5 | 90 | 78.2 | 99.2 | 47 | 52.7 | 54.5 | 64.21 | 28.03 |
| Mental Score | | 53 | 64.2 | 100 | 36 | 41.2 | 57.5 | 61.5 | 91.7 | 91.5 | 80 | 47.7 | 63.5 | 65.66 | 20.85 |

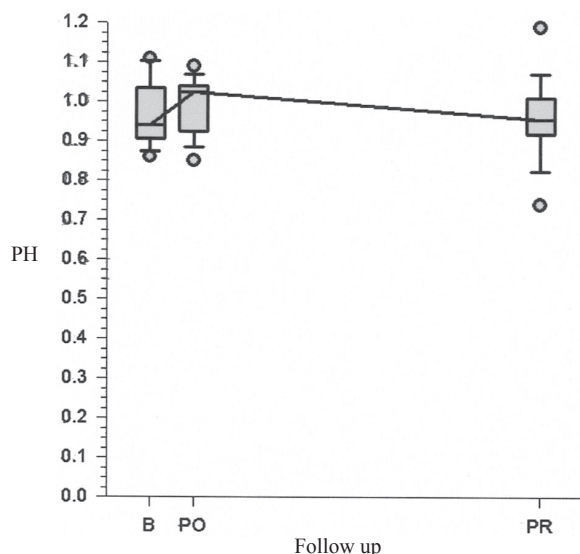


Figure 5 – Posterior height of the fractured vertebra (PH). Values are presented as percentage of the posterior height of the vertebral body immediately above the fracture in three moments: B (pre-operative) mean = 0.94, standard deviation = 0.08; PO (immediate post-operative) mean = 0.98, standard deviation = 0.07; PR (after hardware removal) mean = 0.95, standard deviation = 0.10. There was no significant difference between the values.

no significant difference between the preoperative and final mean angles (ANOVA, $\alpha = 0.801$). On the other hand, a significant improvement in kyphosis was observed after the first surgery (ANOVA, $\alpha = 0.015$), but this gain was lost at the end of treatment. The same pattern of variation was observed with the anterior height of the fractured vertebra [mean B = 0.65 (standard deviation = 0.11); mean PO = 0.82 (standard deviation = 0.13), mean PR = 0.73 (standard deviation = 0.17)]. Again, statistically significant difference was observed only between B and PO (ANOVA, $\alpha = 0.005$). The variations of posterior fractured vertebral body height also followed the same pattern, but no statistically significant difference was found.

Discussion

Clinical results

The neurological results did not differ from the expected in the literature: no deterioration occurred and most incomplete spinal cord injuries improved one Frankel grade after the treatment^{9,15}.

When an outcome is measured by the SF-36, the eight different domains are usually grouped into two

scores: physical (functional capacity, physical aspect, pain and general state of health) and mental (vitality, social aspects, emotional aspect and mental aspect)¹¹. The physical score seems to be very important when one deals with spinal trauma.

Literature is controversial regarding the association between post-operative deformity and physical dysfunction. Some authors report a positive correlation between deformity and pain^{4,20,34}. According to McLain²⁶, pain will be usually present when post-operative kyphosis is bigger than 10°. This is in contradiction to the findings of many other authors^{2,10,12,25,27,29,30,37,38}.

The association between physical score and kyphotic deformity was evident in the present study: patients with final physical score lower than the average presented a higher mean final kyphosis (12.87°; standard deviation = 5.80). Therefore, an inverse correlation between these two variables was observed. This finding suggests that post-operative kyphosis negatively interferes in the quality of life of patients harboring thoracolumbar fractures.

The functional outcomes of some patient series that include both neurologically intact and partially compromised cases are usually based on physical capacity (e.g. return to work, ability to perform physical tasks or sports)^{13,16,18,22,27,30}. The difficulty to perform comparisons among the many reports lays mainly in the variability of the outcome measure instruments.

Kaneda¹⁸ describes his results in terms of the ability to return to the previous job. Eighty six percent of his patients who were previously employed returned to the previous activity. The percentage of heavy laborers is not stated, but the result is judged to be good. McNamara²⁷ reports that 9/13 patients returned to their previous occupation without restrictions. No description of the occupations is presented and the results are considered excellent. An excellent result was also found by Detukoski¹³, in a work similar to the present series: 11/33 patients returned to the previous activity without restriction and 15/33 with restriction. In Parker's series³⁰, among 38 cases treated by posterior short segment fixation, 25 returned to the previous occupation, 8 to a less physically demanding work and 3 retired. The two remaining cases were previously retired or unemployed and remained so. Louis²² considered his results also excellent: among 56 patients treated by posterior instrumentation, 28 went back to full time work and 16 to part time jobs, while 12 did not work anymore. An excellent result was also reported by Ghanayen and Zdeblick¹⁶ in 11 of their 12 patients operated by the anterior approach. Unfortunately the criteria employed to consider a functional result as excellent are not reported.

Return to work may be a misleading criterion. The percentage of heavy laborers included in any series might interfere significantly in this kind of result. According to

Knopp¹⁹, only 50% of heavy laborers ever return to their previous activity. In this regard, the SF-36 may represent a better outcome instrument because it describes more precisely whether the patient can perform light, moderate or heavy work, with or without difficulty.

In the present series, vigorous efforts could be performed without restriction by 16.6% (2/12), moderate efforts without restriction by 33.33% (4/12) and with restriction by another 33.33%. Only 16.6% of patients became unable to perform even moderate physical tasks.

It is not possible to compare precisely the present results to those of other authors. The fact that 10 out of our 12 patients were able to perform heavy or moderate work with little or no restriction seems justify the use of the term "excellent" to describe our clinical results, as used by others. Only one series was found in the literature that used the SF-36 to evaluate the outcome of thoracolumbar fractures³⁶. The final physical score in that series (62.50) was almost identical to ours (64.21).

Radiological results

Significant subsidence was the ultimate result in our patients. This fact makes our proposition as ineffective as any other posterior stabilization technique in the maintenance of the sagittal spinal contour after thoracolumbar compression fractures^{3,6,19,21,26,27,28,31,33}. Available techniques for the treatment of thoracolumbar compression fractures by the posterior approach include: posterior long instrumentation and arthrodesis with Harrington distraction rods, posterior long instrumentation and arthrodesis with Universal Spinal Instrumentation, posterior long instrumentation and fusion with Luque rods or rectangles, rodding long and fusing short with Harrington distraction rods, posterior short segment fixation with the interne fixateur with or without transpedicular bone grafting, as well as the present technique.

When a long arthrodesis is performed there is significant impairment of the mobility of the thoracolumbar junction. Short arthrodesis on the other hand usually progresses to significant late subsidence. It was our intention to overcome both the problem of subsidence and of mobility restriction with the use of our technique. Results showed that the technique failed to do so.

Conclusion

When the rod long/fuse short technique is chosen to treat a thoracolumbar burst fracture, the utilization of Universal Instrumentation does not show any advantage over Harrington distraction rods in terms of radiological and functional outcome.

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