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The efficacy of non-operative treatment of burst fractures of the thoracolumbar vertebrae

Torakolomber vertebra burst kırıklarında konservatif tedavinin etkinliği

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Amaç: Torakolomber vertebra burst kırıklarında konservatif tedavinin etkinliği değerlendirildi.

Çalışma planı: Çalışmaya, tek seviyeli torakolomber vertebra kırığı nedeniyle konservatif tedavi uygulanan 26 hasta (19 erkek, 7 kadın; ort. yaş 36; dağılım 18-67) alındı. Olgularda nörolojik defisit veya posterior kolon tutulumu yoktu; kanal içi deplasman oranı %50 veya altında idi. Fonksiyonel sonuçlar Denis'in ağrı ve iş skalaları kullanılarak değerlendirildi. Takip süresi, Cobb açısındaki artış, rezidüel kifoz ve rezidüel kanal darlığı ile fonksiyonel sonuçlar arasındaki ve incelenen radyolojik parametrelerin birbirleri ile ilişkileri değerlendirildi.

Sonuçlar: Fonksiyonel sonuçlar %65.3 oranında mükemmel veya iyi, %7.7 oranında kötü bulundu. Üç hasta ağrı nedeniyle ameliyat edildi. Son kontrollerde, ortalama Cobb açısında anlamlı artış (p<0.001), kanal içi daralmada ise anlamlı derecede remodelizasyon (p<0.001) saptandı. Cobb açısındaki artış, rezidüel kifoz ve rezidüel kanal darlığı ile fonksiyonel sonuçlar arasındaki ilişki anlamlı bulunmadı (p>0.05). Hastaneye yatış anındaki Cobb açısı ile yatış anındaki kanal daralması (p<0.05), başlangıçtaki kanal daralması ile kanal remodelizasyonu arasında anlamlı ilişki saptandı (p<0.001).

Çıkarımlar: Torakolomber vertebra kırıklarında konservatif tedavi etkin bir yöntem olmakla birlikte, bazı hastalarda fonksiyonel sonuçlar kötü olabilmekte veya sonraki dönemde cerrahi tedavi gerekebilmektedir. Bu nedenle, hangi hastalarda kötü sonuç alınabileceğini gösterebilecek prognostik parametreleri belirlemek için ileriye dönük, randomize, karşılaştırmalı ve uzun dönem takipli çalışmalara ihtiyaç vardır.

Anahtar sözcükler: Kemik remodelizasyonu; lombar vertebra/yaralanma/radyografi; lumbosakral bölge/yaralanma; omurga kırıkları/tedavi/komplikasyon/radyografi; omurga stenozu/etiyoloji; torasik vertebra/yaralanma; bilgisayarlı tomografi.

Objectives: We evaluated the efficacy of non-operative treatment of thoracolumbar burst fractures.

Methods: The study included 26 patients (19 males, 7 females; mean age 36 years; range 18 to 67 years) who underwent conservative treatment for single-level thoracolumbar fractures without posterior column involvement. None of the patients had neurologic deficits and canal encroachment was 50% or less in all fractures. Functional results were evaluated with the use of Denis' pain and work scales. Relationships were sought between functional results and follow-up time, progression in kyphosis angle, residual kyphosis, and residual canal stenosis, and between radiologic parameters.

Results: Functional results were excellent or good in 65.3%, and poor in 7.7%. Three patients required surgery because of pain. Final follow-up evaluations showed a significant progression in the mean Cobb angle (p<0.001) and a significant remodelization in the mean canal encroachment (p<0.001). No significant correlations were found between progression in kyphosis, residual kyphosis, residual canal stenosis, and functional results (p>0.05). The mean initial Cobb angle was correlated with the mean initial canal encroachment (p<0.05). There was also a correlation between the initial canal encroachment and final remodelization (p<0.001).

Conclusion: Although non-operative management of thoracolumbar fractures has considerable efficacy, it may yield poor results in a small percentage of patients, some of whom require surgery because of pain. Thus, further prospective, randomized, and comparative studies with longer follow-up periods are required to define prognostic factors that may predict poor results following non-operative treatment.

Key words: Bone remodeling; lumbar vertebrae/injuries/radiography; lumbosacral region/injuries; spinal fractures/therapy/complications/radiography; spinal stenosis/etiology; thoracic vertebrae/radiography; tomography, X-ray computed.

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While deteriorating neurological status is widely accepted by all authors as a true indication for early surgical intervention in thoracolumbar burst fractures, almost all of the other indications concerning treatment are currently subjects of discussion.[1-16] Denis et al[17] reported late neurological manifestations in 17% of conservatively treated patients; while other studies reported this rate to be 0-3%.[18-22]

Various studies have evaluated the results of conservative treatment in terms of residual kyphosis and spinal stenosis; however, no correlation could be demonstrated between these parameters and functional results, especially in healthy subjects.[18,20,22-24]

Patients and method

26 patients (19 males, 7 females; mean age 36 years, age range 18-67 years) treated conservatively between years 1997 and 2000, with single level burst fracture of the thoracolumbar vertebra and no neurological deficit (Frankel E), spinal canal involvement degree lesser than 50% and no posterior column involvement, were included in the study.

During the emergency admission, all patients were evaluated with AP and lateral radiographs and CT scans of the vertebra after orthopaedic and neurological examinations were performed. The level involved was T_{11} in three patients (%11.5), T_{12} in 8 (%30.8), L_1 in 9 (%34.6), L_2 in 4 (%15.4), L_3 in 2 (%7.7).

Lateral radiographs obtained in the supine position were used to measure the Cobb angle (the angle between the upper end-plate of the vertebral body over the fractured vertebra and the lower end-plate of the vertebral body below the fractured vertebra).[25] Width of the spinal canal in CT scans were measured using the method described by Willen et al.[26] A height reduction of more than 50% in the anterior portion of the vertebral body, distraction between spinous processes, fracture or subluxation of the facet joints, laminar fracture or fracture of the interarticular process were all evaluated as signs of posterior column involvement.

Treatment protocol

Patients were given standard hospital beds. Reduction was not attempted in any of the patients. Non-narcotic analgesics were prescribed. Side turns and movement of the extremities were allowed within the bed. After the relief of abdominal distension or ileus, if present, a hyperextension brace was applied to 21 patients and hyperextension cast to 5 patients two days after the injury. Following immobilization using cast or orthosis, patients were allowed to move with the help of another person, limited by their degree of tolerance. Neurological examination was performed every day during their stay in the hospital. When the pain could be controlled with oral medication, they were discharged. Additional fractures were treated as necessary. Patients were invited for follow-up examinations 45 days, three months, six months and one year after discharge from the hospital. After the first year, yearly controls were continued, when neurological examination was again performed, AP and lateral radiographs were evaluated. The hyperextension orthosis was used for 16-24 weeks. In two patients with hyperextension cast, the cast was removed due to patient intolerance after 45 days and hyperextension orthosis was applied. The other three patients were switched to hyperextension orthosis after 3 months. Patients were followed-up for a mean period of 42.9 months (range 12-63 months).

Final follow-up examination

The final follow-up examination consisted of

Table 1. Denis' functional assessment scale[17]

Pain scale		Work scale	
P_1	No pain	W_1	Back to work (heavy work)
P_2	Mild pain rarely, no need for medication	W_2	Back to work (sedantary) or limitation in weight liftin or back to heavy work which needs work modifications
P_3	Mild pain; rarely necessitates medication; does not influence or hinder daily activities	W_3	Back to work not possible but full-time work necessary; new job
P_4	Moderate-severe pain; frequently necessitates medication; rarely hinders work or influences daily activities	W_4	Back to work not possible, part-time job due to pain
P_5	Chronic or crippling pain, chronic medication	W_5	No work, fully disabled

Tablo 2. Functional assessment with modified Denis'

Score*	Functional result
1	Perfect
2	Good
3	Moderate
4	Bad
5	Very bad

*The lower score from either the pain or work scale is considered (e.g. P_1-W_3 "moderate" orP_2-W_1 "good").

neurological evaluation, AP and lateral radiographs. CT was used to measure the amount of stenosis in the spinal canal. Patients were assessed functionally using the pain and work scale of Denis et al[17] (Table 1). The pain and work scales were combined and modified; thus, grouping the functional results as perfect, good, moderate, bad or very bad (Table 2).

Statistical analysis

Differences between the Cobb angles and the degree of spinal stenosis at initial emergency admission and final follow-up examination (mean increase in Cobb angle and average remodelling) were compared using paired *t*-test.

Pearson's correlation analysis was to used evaluate the relationships between the length of follow-up period and age, and increase in Cobb angle and canal remodeling; between age and functional results; between initial Cobb angle and increase in Cobb angle; between initial Cobb angle and initial spinal stenosis, between initial spinal stenosis and canal remodeling and between increase in Cobb angle and canal remodeling.

Spearman's correlation analysis was used to assess the increase in Cobb angle and Cobb angle at final follow-up, and spinal stenosis and functional results.

Results

Mean hospital stay was 5.3 days (range 3-12 days). Excluding seven patients with additional fractures, the mean hospital stay was found to be 4.4 days (range 3-10 days). None of the patients developed late neurological deficits. Thromboembolism or pressure wounds were not observed.

Eight patients (30.7%) did not complain of pain (P_1). Occasional pain in eleven patients (42.3%) did not require any medication (P_2). In seven patients (27%) the pain did not influence daily activities or work, but required medication (P_3). 20 patients (77%) could go back to their previous jobs, 9 of which (45%) were able to do heavy work (W_1), while 11 patients were not (55%) (W_2). Four patients (15.4%) had to change their jobs and prefered work with less physical exertion (W_3). Two patients (7.7%) had to work part-time due to pain (W_4).

In terms of functional results, seven patients had perfect (27%), ten had good (38.3%), seven (27%) mild and two (7.7%) bad results. Very bad functional results were not observed.

Three patients (11.5%) were operated due to pain; one patient received anterior decompression and fusion, while the other two received posterior fusion. The preoperative bad (P_3-W_4) functional result of the patient who received anterior decompression and fusion, was found to be good postoperatively (P_1-W_2). One of the patients receiving posterior fusion had moderate functionality (P_3-W_3) preoperatively and good functional results (P_1-W_2) postoperatively. The other patient could not be evaluated since he was in the early postoperative period.

The mean increase in Cobb angle at final examination was 8.31±4.38° (initial Cobb19.88±5.36°, final follow-up 28.19±5.62°). This increase was statistically significant ($p<0.001$) (Figure 1a, b).

Spinal stenosis which was 35.45%±10.30 initially was reduced to %17.34±4.00. This spinal canal remodeling was statistically significant ($p<0.001$) (Şekil 2a, b).

The length of the follow-up period and increase in Cobb angle showed correlation ($r=0.55$, $p<0.01$), spinal canal remodeling and increase in Cobb angle did not ($r=0.20$, $p>0.05$).

Age and increase in Cobb angle ($r=0.09$, $p>0.05$), canal remodeling ($r=0.31$, $p>0.05$), Denis' pain ($r=-0.16$, $p>0.05$) and work scales ($r=0.11$, $p>0.05$) were statistically not correlated.

There was no correlation between initial Cobb angle at admission and increase in Cobb angle ($r=-0.34$, $p>0.05$, while it was correlated with initial spinal stenosis at admission($r=0.49$, $p<0.05$). There was a significant correlation between initial spinal stenosis and spinal canal remodeling ($r=0.96$, $p<0.001$).

There was no correlation between the increase in Cobb angle and spinal canal remodelling (r=-0.22, p>0.05), Denis' pain (r=-0.22, p>0.05) and work (r=-0.52, p>0.05) scales. Similarly, the Cobb angle at final follow-up (residual kyphosis) and Denis' pain (r=0.08, p>0.05) and work (r=-0.59, p>0.05) scales were also not correlated. The difference between spinal stenosis at final follow-up (rsidual spinal stenosis) and Denis' pain (r=-0.12, p>0.05) and work (r=0.14, p>0.05) scale was not statistically significant.

Discussion

Treatment of thoracolumber burst fractures is currently contrversial. Deterioration of neurological status is an indication for emergency surgery, while all other indications are still subjects of debate.[1-16]

Many authors indicate that destruction of the osteoligamentous complex of the middle column (especially in the presence of intraspinous displacement) causes instability and increases the risk of neurological deterioration; and thus, they recommend surgery.[1-10] Some studies however, propose conservative treatment in these cases.[11-16]

Denis et al[17] reported late neurological deterioration in 17% of conservatively treated patients. Latter studies report this late neurological deterioration rate as 0-3%.[18-22] In our study, none of the 26 patients demonstrated late neurological deterioration following conservative treatment. Moreover, late neurological deterioration may be reversible to some extent with surgical intervention. Denis et al[17] reported late neurological deterioration in four patients, three of whom could be treated surgically. In a study by Mumford et al[20] the late neurological deterioration observed in one patient could completely be reversed with surgical treatment.

Besides late neurological deficits, another subject of concern in thoracolumbar fractures is gradual development of late deformity (progressive kyphosis). Despite conservative treatment, it is well known that the kyphotic deformity in the fracture site is progressive.[18-20,23,27,28] Short segment posterior instrumentation, which relatively has less morbidity as compared to others, causes a loss of correction of 10° or more in 40-50% of patients.[29-33] 1° and 1.5°

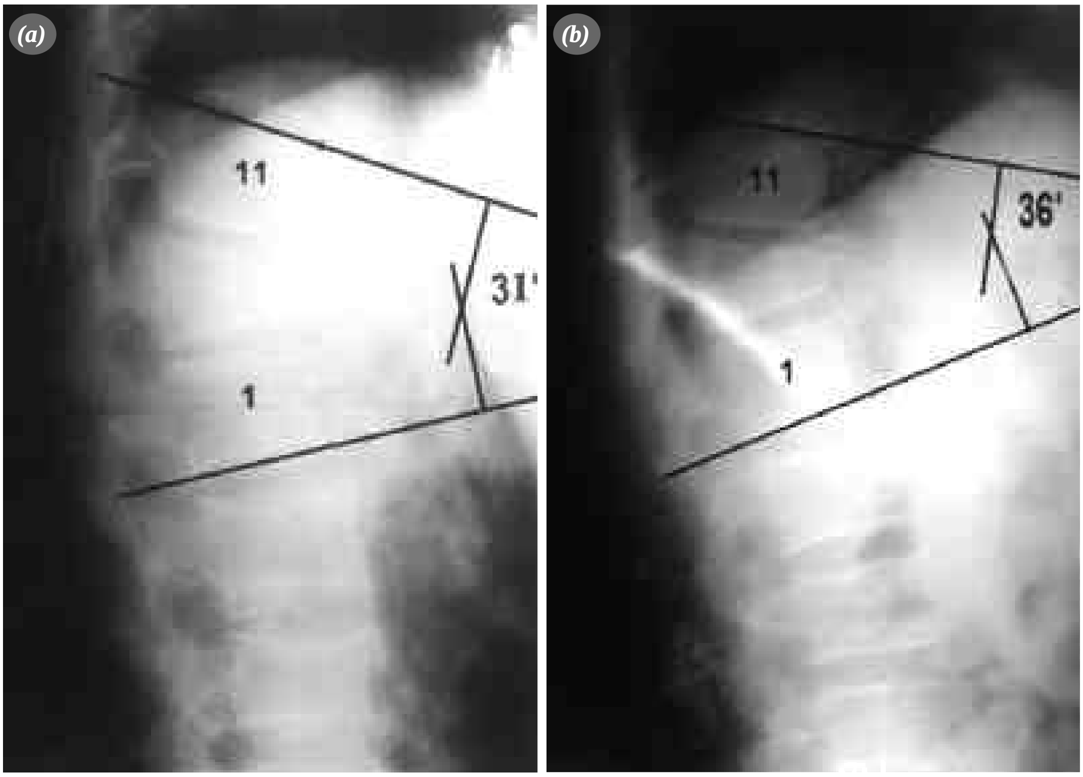
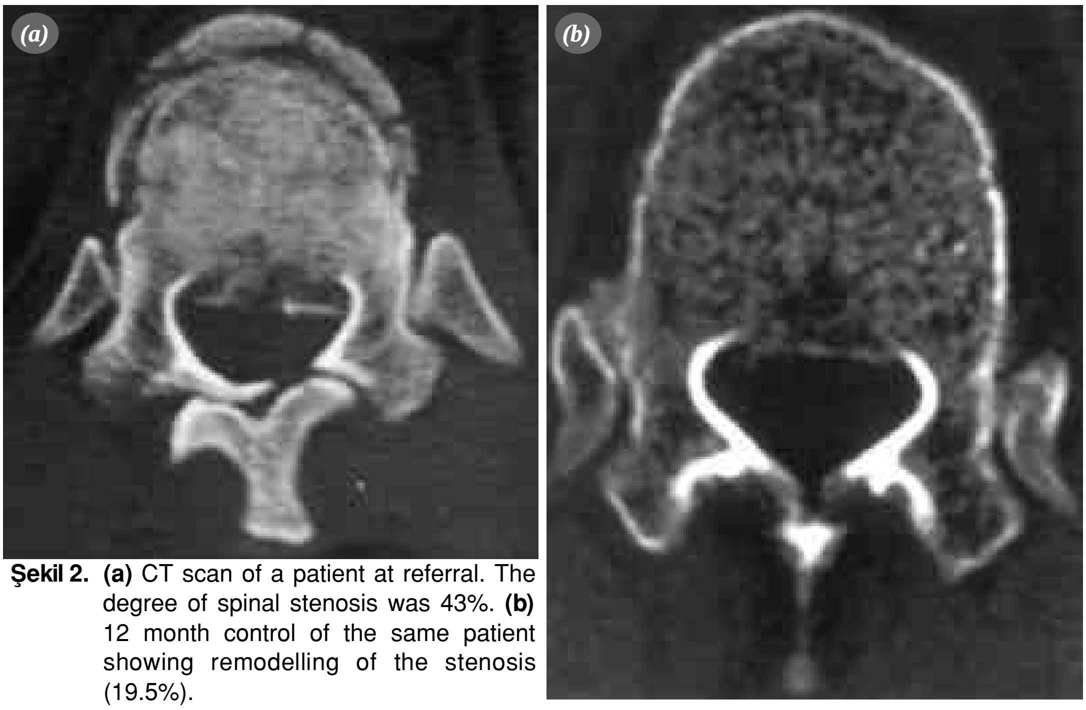


Figure 1. **(a)** Initial lateral radiograph of a T12 burst fracture with Cobb angle 31°. **(b)** 12 month follow-up radiograph of the same patient after conservative treatment, Cobb angle has increased to 36°.

of correction loss were reported respectively, for anterior surgery and 2HS-1SH structure (Argenson method), which are considered to have higher rates of morbidity.[34,35] On the other hand, many studies have failed to demonstrate any correlation between the progression of kyphotic deformity and the functional results of the patients.[18-20,23,27] No statistically significant differences could be shown between conservative treatment and posterior fixation in terms of functional results, starting from 6 months postoperatively.[33] Our results also coincide with the results of the studies mentioned. Kyphotic deformity progressed in all of our patients. However, no correlation could be found between functional outcome and a mean increase of 8.31±4.38° ($p<0.001$) in kyphotic deformity ($r=0.38$, $p>0.05$ and $r=-0.52$, $p>0.05$). Despite demonstration of a correlation between increase in Cobb angle and follow-up period ($r=0.55$, $p<0.01$), it was not possible to know until when the increase in kyphotic deformity continued since some of the patients could only be examined in the final examination after the first year controls. Moreover, no correlation could be found between the increase in Cobb angle and age or initial Cobb angle.

Like most studies in the literature, our study also shows that no correlation exists between the increase in Cobb angle and functional outcome; however, Oner et al[36] report that increase in kyphotic deformity is correlated with pain. Oda et al[37], in an animal model, have shown that following kyphotic deformity, compensatory hyperlordosis in the cephalad neighbour of the affected vertebra, lordotic contracture in the posterior ligamentous complex, increase in laminar tension and degenerative changes in the cephalad neighboring facet joint could occur. Today, most authors working on surgical treatment of burst fractures cite the study by Bohlman et al[38]. In this study, late complaints of pain and paralysis were observed in 36 patients with burst fractures, within 4.5 years after occurrence of the fractures, and anterior decompression performed in these patients had successfully reduced pain and paralysis.

Another subject of discussion for throracolumbar burst fractures is bony fragments in the spinal canal and the stenosis they cause. Many studies indicate that a spinal stenosis of 30-50% constitute an indication for surgery.[3,5,7,9,10,17,28] However, intraspinal fragments show remodeling also after conservative treatment. Mumford et al[20] indicate that about two thirds of intraspinal fragments are resorbed and most of them show complete remodeling within one year. De Klerk et al[39] have shown that, with conservative treatment, even in patients with neurological deficits, the degree of spinal stenosis shows a reduc-



Şekil 2. **(a)** CT scan of a patient at referral. The degree of spinal stenosis was 43%. **(b)** 12 month control of the same patient showing remodelling of the stenosis (19.5%).

tion of 50% within the first year and that remodeling is not affected by the presence of neurological deficits. Yazıcı et al[40] reported that among all patients treated, those who received surgical treatment had a more prominent spinal canal remodeling as compared to the conservatively treated patients; however, there was no statistically significant difference in terms of spinal canal cross-sectional area between the two groups after the treatment is complete. Dai[41] also reported that no significant difference could be demonstrated between the surgically treated group, conservatively treated group and the group which was not treated at all, in terms of the amount of remodeling. In our study, the mean initial spinal stenosis was 14-50% (mean 35.45% ± 10.30%). This initial spinal stenosis was correlated with the initial Cobb angle at admission($p<0.05$). However, spinal stenosis showed remodeling in all patients (mean 49.29%±9.28%; $p<0.001$). No correlation was found between the length of the follow-up period and canal remodeling in our study. In the literature, the most significant remodeling in spinal canal stenosis is reported to develop within the first 12 months and that remodeling after that period is not significant.[39] Spinal canal remodeling is independent of patient age or increase in Cobb angle. On the other hand, the amount of stenosis at the fracture site initially is correlated with spinal canal remodeling ($r=0.96$, $p<0.01$). The higher the amount of initial stenosis in the spinal canal, the better the remodeling. In our study, no complete remodeling was observed, but the degree of stenosis reduced to less than 30% in all patients (mean 17.34%±4.00%).

In our study, the increase in Cobb angle, residual kyphosis angle and residuel spinal stenosis were not correlated with functional outcome and perfect or good functional results could be obtained in 65.3% of the patients; however, three patients were surgically treated due to pain. In two of these patients, the pain significantly reduced after surgery and their physical capabilities increased. The third patient could not be evaluated functionally since he was in the early period after injury. In many studies, various parameters and functional outcome are not correlated, some patients are operated on due to symptoms like pain. In the literature, no specific parameter scould be identified to determine which conservatively treated patients were to have unsatisfactory final outcome.

Prospective, radomized, comparative and long-term studies are necessary to determine the prognostic critea about treatment options for thracolumbar burst fractures without accompanying neurological deficit.

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