

Original article

Long-term Outcomes of Hyperextension Casting vs Short-segment Instrumentation in TLICS 4 Thoracolumbar Fractures

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Received: 12 June 2025

Revised: 03 July 2025

Accepted: 11 July 2025

Published: 31 August 2025

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Citation: Halil Gök, Alim Can Baymurat. Long-term Outcomes of Hyperextension Casting vs Short-segment Instrumentation in TLICS 4 Thoracolumbar Fractures. *Trauma & Ortho Kaz*, 2025, 76 (4), jto012
<https://doi.org/10.52889/1684-9280-2025-76-4-jto012>

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Abstract

This study aimed to compare long-term clinical and radiological outcomes of conservative treatment using hyperextension casting versus surgical treatment (short-segment instrumentation) for thoracolumbar vertebral fractures classified as Thoracolumbar Injury Classification and Severity Score (TLICS) score 4.

Methods. Patients diagnosed with stable compression fractures at T10–L2 who underwent conservative hyperextension casting (Group A, n=28) or surgical short-segment instrumentation (Group B, n=36) between 2004 and 2014 were retrospectively reviewed. Pain levels (Visual Analogue Scale), functional outcomes (Oswestry Disability Index), local kyphosis angle (Cobb Angle), anterior vertebral body height compression (ACVBH), and patient satisfaction were evaluated.

Results. There were no significant differences between groups regarding age, gender, BMD, or follow-up duration. Hospital stay was significantly longer in Group B (5.1±2.5 vs. 2.1±0.7 days; p<0.001, Cohen's d=1.55). Radiological parameters (Cobb angle, ACVBH, SI) showed no significant differences at final follow-up. However, Group B demonstrated significantly superior outcomes in Oswestry Disability Index (ODI) at follow-up (p<0.001, Cohen's d=1.23) and Visual Analogue Scale (VAS) scores at pre-treatment (p=0.047, Cohen's d=0.53), post-treatment (p=0.024, Cohen's d=0.57), and follow-up (p<0.001, Cohen's d=1.18). Complication rates were comparable between groups.

Conclusion. Hyperextension casting provided similar radiological outcomes to surgical treatment, although surgical intervention offered better functional outcomes and pain relief. Treatment choice should consider individual patient factors and fracture characteristics.

Keywords: Thoracolumbar fracture, hyperextension cast, short-segment instrumentation, kyphosis angle, functional outcome.

1. Introduction

The evaluation of systolic function of the left ventricle is a crucial characteristic which defines the thoracolumbar junction (T10–L2) is anatomically more vulnerable to trauma due to its location as a transitional region between the rigid thoracic spine and the mobile

lumbar spine [1,2]. Therefore, fractures of the thoracolumbar region account for up to approximately 90% of all spinal fractures [3].

TLICS is a widely utilized classification system in the management of vertebral fractures, evaluating injury morphology, integrity of the posterior ligamentous complex, and neurological status [4]. For stable fractures, conservative treatment is generally recommended if the TLICS score is 3 or below, whereas surgical intervention is preferred for scores of 5 or above. However, the optimal management strategy for fractures with a TLICS score of 4 remains controversial. While some studies suggest that conservative treatment may yield sufficient outcomes, others advocate for

surgical stabilization to achieve superior clinical and radiographic results [5,6].

This study aims to evaluate the long-term radiological and functional outcomes of hyperextension casting versus surgical treatment (short-segment instrumentation) in patients with TLICS score 4 thoracolumbar vertebral fractures and to analyze the findings in comparison with existing literature.

2. Materials and Methods

Patients diagnosed with stable vertebral fractures between levels T10–L2, who underwent either conservative treatment (hyperextension casting) or surgical intervention (short-segment posterior instrumentation) from 2004 to 2014, were retrospectively analyzed.

Inclusion and Exclusion Criteria:

Patients aged 18 years or older with TLICS score of 4, treated conservatively or surgically, and having at least 10 years of follow-up were included in this study. Patients presenting with neurological deficits, osteoporosis (T-score < -2.5), or pathological fractures were excluded (Figure 1).

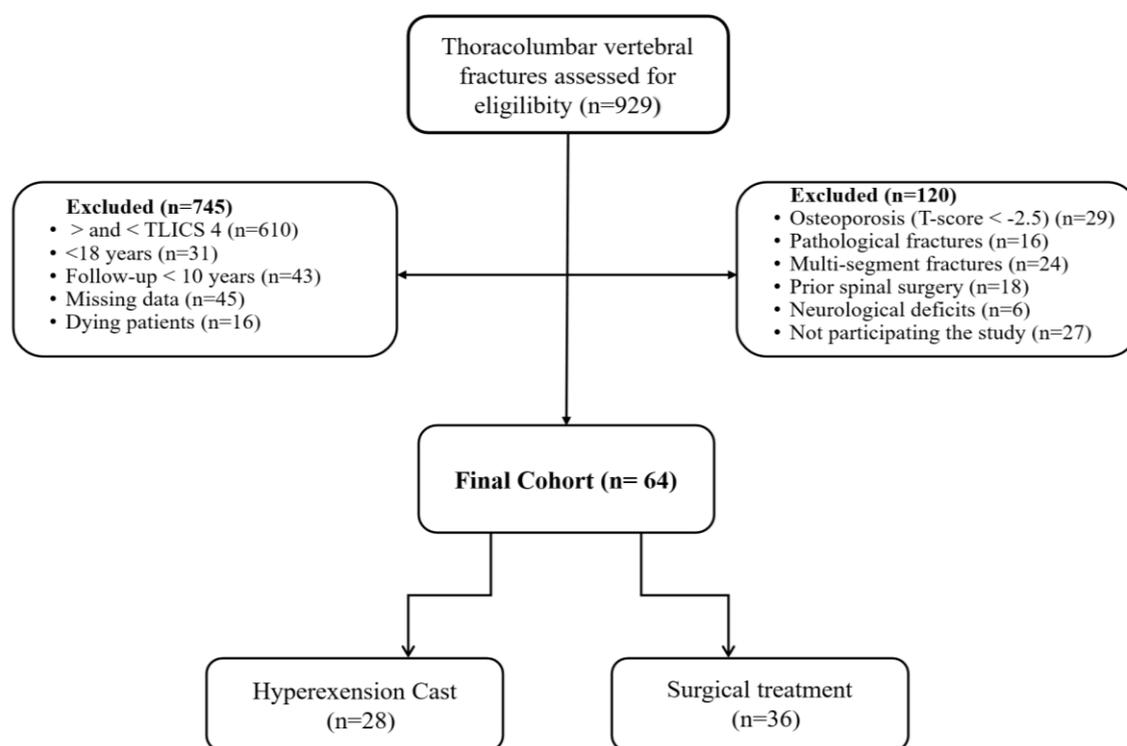


Figure 1 – Patient flowchart

Medical records and imaging archives of the patients were retrospectively reviewed. Data collected included age, gender, fracture level, pain scores (VAS), functional scores (ODI), and local kyphosis angles measured at baseline, post-treatment, and final follow-up evaluations.

Local kyphosis angle was calculated using the Cobb method by measuring the angle formed between the superior endplate of the vertebra above and the inferior endplate of the vertebra below the fractured segment.

For sagittal index (SI) assessment, reference sagittal curvatures were defined as 5° for thoracic segments, 0° at the thoracolumbar junction, and -10° for lumbar segments.

The percentage of ACVBH was determined by dividing the anterior height of the fractured vertebral body by the average of the anterior heights of the vertebral bodies immediately above and below it, multiplied by 100 [7].

During hyperextension cast application, patients were positioned prone, suspended between two tables to achieve maximum lordotic alignment of the thoracic and lumbar spine.

A body cast extending from the axilla to the thoracolumbosacral region was applied to provide external stabilization. The cast was meticulously shaped to ensure anatomical reduction and allowed to harden in the reduced position. To avoid restricting respiratory function, a window of appropriate size was opened in the thoracoepigastric region. Following casting, patients were permitted to mobilize without restrictions as soon as their pain levels became tolerable, typically on the same day (Figure 2).

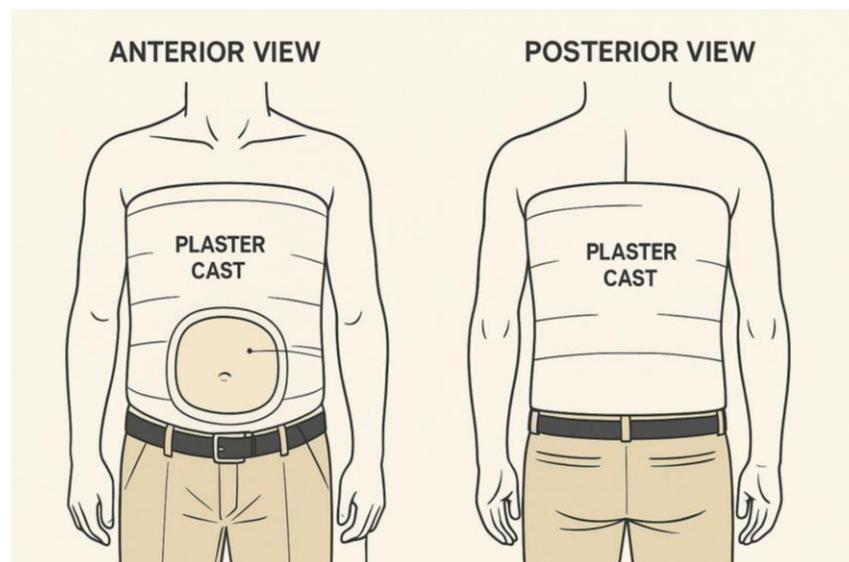


Figure 2 – A window was cut into the hyperextension splint to avoid impairing respiratory function, and patients were allowed to mobilize on the same day

Statistical Analysis

Statistical analyses were performed using SPSS version 25 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean \pm standard deviation (SD), and categorical variables as number and percentage [n (%)].

The normality of the data was assessed by the Shapiro-Wilk test. Independent Samples t-test was used

to compare normally distributed variables (e.g., age, BMD index, and follow-up duration), while Mann-Whitney U test was applied for variables not conforming to normal distribution (e.g., ODI and VAS scores). Chi-square test was utilized to compare categorical variables (gender distribution). Statistical significance was set at $p < 0.05$, and Cohen's d was calculated for variables showing statistically significant differences.

3. Results

Short-segment posterior instrumentation was performed as the surgical treatment (Figure 3).

On the day following either surgical intervention or hyperextension casting, patients were assisted by a physiotherapist to stand and walk. During hospitalization and bed rest, no thromboembolic

complications or pressure ulcers occurred. Additionally, no complications such as allergic reactions, skin lesions, or fungal infections related to cast use were observed.

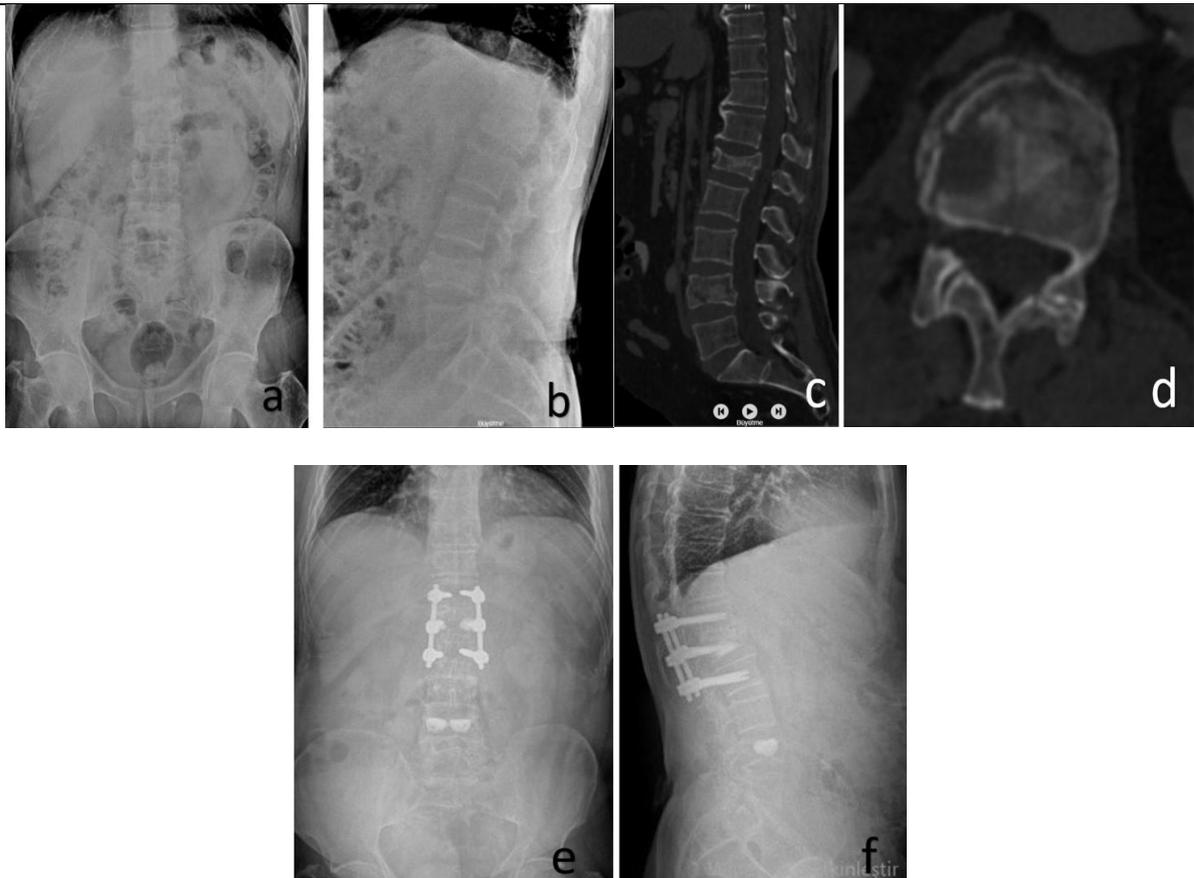


Figure 3 – Short segment posterior instrumentation for L1 lumbar vertebral fracture. Preoperative plain radiographs (a, b), computed tomography images (b, c), and postoperative plain radiographs (e, f)

A total of 64 patients were included, with 36 in the surgical group and 28 in the cast group. No significant differences were observed between the two groups regarding age ($p > 0.05$), gender distribution ($p > 0.05$), bone mineral density (BMD) index ($p > 0.05$), or duration of follow-up ($p > 0.05$). However, a significant

difference was detected in the length of hospital stay, with the surgical group having a significantly longer hospital stay compared to the cast group (5.1 ± 2.5 days vs. 2.1 ± 0.7 days, respectively; $p < 0.001$).

The demographic characteristics of the study population are presented in Table 1.

Table 1 – Comparison of demographic characteristics between surgical and cast groups

Feature	Surgery Group (n=36)	Cast Group (n=28)	p-value
Age (years)	45.8 ± 13.6	46.1 ± 15.2	0.771
Male (n, %)	19 (52.8%)	15 (53.6%)	1.000
Female (n, %)	17 (47.2%)	13 (46.4%)	1.000
BMD Index	28.9 ± 2.1	29.1 ± 3.2	0.752
Follow-up Duration (years)	14.8 ± 2.9	15.3 ± 2.5	0.523
Length of Hospital Stay (days)	5.1 ± 2.5	2.1 ± 0.7	0.000*

Note: Values are presented as mean ± standard deviation or number (percentage). Statistically significant p-values are marked with an asterisk (*)

Radiological outcomes are summarized in Table 2. No statistically significant differences were observed between surgical and cast groups for COBB angles (pre-treatment, post-treatment, and follow-up), ACVBH values (pre-treatment, post-treatment, and follow-up),

and SI angles (pre-treatment, post-treatment, and follow-up).

Table 2 – Comparison of radiological results between surgical and cast groups

Feature	Surgery Group (n=18)	Cast Group (n=17)	p-value
COBB Angle - Pre-treatment (°)	16.1 ± 4.7	15.6 ± 4.3	0.448
COBB Angle - Post-treatment (°)	9.7 ± 7.7	5.9 ± 7.6	0.052
COBB Angle - Follow-up (°)	10.9 ± 5.5	13.2 ± 5.1	0.359
ACVBH - Pre-treatment (%)	40.6 ± 11.7	38.5 ± 12.4	0.310
ACVBH - Post-treatment (%)	18.7 ± 9.8	19.5 ± 7.3	0.967
ACVBH - Follow-up (%)	24.5 ± 13.0	27.1 ± 11.3	0.790
SI - Pre-treatment (°)	16.3 ± 6.2	16.1 ± 5.9	0.592
SI - Post-treatment (°)	11.4 ± 5.1	9.7 ± 5.3	0.143
SI - Follow-up (°)	14.1 ± 6.7	13.9 ± 5.8	0.623

Note: Values are presented as mean ± standard deviation. Statistically significant p-values are marked with an asterisk (*)

Functional outcomes are summarized in Table 3. No statistically significant differences were detected

between groups in terms of ODI and VAS scores at pre-treatment, post-treatment, and follow-up evaluations.

Table 3 – Comparison of functional outcomes between surgical and cast groups

Feature	Surgery Group (n=18)	Cast Group (n=17)	p-value
ODI - Pre-treatment	71.1 ± 7.3	69.2 ± 5.2	0.221
ODI - Post-treatment	52.3 ± 6.8	50.9 ± 6.9	0.276
ODI - Follow-up	35.4 ± 5.3	30.2 ± 2.7	0.000*
VAS - Pre-treatment	7.8 ± 0.8	7.4 ± 0.7	0.047*
VAS - Post-treatment	5.3 ± 0.6	4.9 ± 0.8	0.024*
VAS - Follow-up	3.2 ± 0.4	2.6 ± 0.6	0.000*

Note: Values are presented as mean ± standard deviation. Statistically significant p-values are marked with an asterisk (*)

Statistically significant differences were identified between the groups in terms of hospital stay duration (p<0.001, Cohen's d=1.55), ODI scores at follow-up (p<0.001, Cohen's d=1.23), VAS scores at pre-treatment

(p=0.047, Cohen's d=0.53), post-treatment (p=0.024, Cohen's d=0.57), and follow-up (p<0.001, Cohen's d=1.18).

4. Discussion

This study aimed to compare the long-term clinical and radiological outcomes of hyperextension casting, commonly used in the conservative treatment of stable thoracolumbar vertebral fractures, with surgical treatment (short-segment instrumentation). Our results demonstrated that hyperextension casting provided comparable results to surgical treatment in maintaining the kyphosis angle, with no statistically significant difference observed between the groups (p=0.359).

However, surgical treatment yielded superior results in terms of functional improvement (p<0.001) and pain management (p<0.001); these findings are consistent with several previous studies in the literature [8-10].

Hyperextension cast (HEC) immobilizes the spine in a hyperextended position for compression fractures involving the anterior column, aiming to limit flexion forces and prevent the progression of kyphotic deformity [11]. Particularly when applied during the

acute phase, HEC facilitates spinal segment realignment, thereby enhancing load distribution and contributing to spinal stability.

It is known that hyperextension casting effectively stabilizes the anterior column, thereby preventing the progression of kyphotic deformity [11]. In our study, the long-term maintenance of reduction achieved by casting, particularly at the T12–L1 levels, supports the hypothesis that hyperextension casting is biomechanically comparable to surgical treatment. Although hyperextension casting provided comparable radiological outcomes, practical disadvantages such as limited patient compliance and delayed mobilization, highlighted in previous studies, should be considered. Nevertheless, hyperextension casting has been increasingly abandoned in clinical practice due to issues related to patient compliance and prolonged immobilization periods, as reported in the literature [12].

Another noteworthy finding is the similarity of complication rates between the two groups, indicating that both treatment methods are safe and can yield successful outcomes when patients are appropriately selected.

Although surgical treatment showed superior functional outcomes, no significant differences were

observed between the groups regarding radiological parameters such as Cobb angle, sagittal index, and restoration of anterior vertebral height. This suggests that conservative treatment, when coupled with careful patient selection and consistent follow-up, could effectively preserve spinal alignment – a finding consistent with the results reported by Wood et.al. [8]. Thus, conservative treatment protocols with meticulous follow-up can be regarded as a safe therapeutic alternative.

Our findings demonstrate that hyperextension casting can achieve radiological outcomes comparable to surgical treatment, indicating it should not be overlooked, especially in preserving kyphosis angle. These results highlight the necessity of reevaluating treatment protocols, and our study provides robust evidence supporting the effectiveness of this method.

The primary limitations of this study include its retrospective design and relatively small sample size. However, the extensive follow-up period (mean duration: 15.0 ± 2.7 years), enhances the reliability of our findings. Future multicenter, prospective studies with larger cohorts are required to confirm and strengthen our results.

5. Conclusions

This study indicates that both conservative and surgical approaches can effectively manage TLICS 4 thoracolumbar fractures. The selection of treatment modality should be individualized, carefully considering fracture morphology, patient-specific factors, and overall clinical condition. Further large-scale prospective studies are necessary to reinforce these findings.

Conflicts of Interest. The authors declare no conflicts of interest.

Funding. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Availability of Data and Materials. The data used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Acknowledgments. The authors would like to thank all hospital staff for their dedicated efforts. Additionally, figure 2 was created and language editing was supported using ChatGPT (OpenAI).

Ethics Approval and Consent to Participate. Ethics committee approval was obtained for this study. Informed consent was obtained from all patients included in the study.

Clinical Trial Number. Not Applicable.

Author Contributions: Conceptualization – H.G.; Data analysis – H.G., A.C.B.; Writing - original draft – H.G.; Writing - review and editing – H.G., A.C.B. All authors read and approved the final version of the manuscript.

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Кеуде-бел аумағының сынықтардағы гиперэкстензия иммобилизацияның ұзақ мерзімді нәтижелерін қысқа сегментті бекітумен TLICS 4 бойынша салыстыру

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Түйіндеме

Бұл зерттеудің мақсаты TLICS 4 бойынша кеуде-бел аумағы сынықтарында гиперэкстензиялық иммобилизацияны қолданатын консервативті емнің ұзақ мерзімді клиникалық және рентгенографиялық нәтижелерін хирургиялық емдеумен (қысқа сегментті бекіту) салыстыру болды.

Әдістері. T10-L2 деңгейінде тұрақты компрессиялық сынықтары бар, гиперэкстензиялық гипспен (А тобы, n=28) немесе хирургиялық қысқа сегментті бекітумен (В тобы, n=36) консервативті ем жүргізген науқастарға ретроспективті талдау жасалды. Ауырсыну деңгейі (визуалды аналогтық шкала, ВАШ), функционалдық нәтижелер (Oswestry мүгедектік индексі), жергілікті кифотикалық бұрыш (Кобб бұрышы), алдыңғы омыртқа денесінің биіктігінің қысылу дәрежесі және пациенттің қанағаттануы бағаланды.

Нәтижелер. Жасы, жынысы, сүйек минералды тығыздығы (СМТ) және бақылау ұзақтығы бойынша топтар арасында айтарлықтай айырмашылықтар болған жоқ. В тобында госпитализацияның ұзақтығы айтарлықтай жоғары болды (5,1±2,5-ке қарсы 2,1±0,7 күн; p<0,001, Коэн d=1,55). Соңғы бақылау кезінде рентгенографиялық параметрлерде (Кобб бұрышы, ACVBN, CI) айтарлықтай айырмашылықтар болған жоқ. Дегенмен, В тобы ұзақ мерзімді кезеңде (p<0,001, Коэннің d=1,23), сондай-ақ емдеуге дейінгі (p=0,047, Коэннің d=0,53), емдеуден кейінгі (p=0,024, Коэннің d=0,53 және кейінгі кезеңдегі) ВАШ ұпайларын (p<0,001, Коэннің d=1,23), айтарлықтай жақсырақ Oswestry индексінің көрсеткіштерін көрсетті. d=1,18). Екі топта да асқыну деңгейі салыстырмалы түрде бірдей болды.

Қорытынды. Гиперэкстензиялық гипс иммобилизациясы хирургиялық емдеумен салыстырғанда ұқсас рентгенографиялық нәтижелерді береді, бірақ хирургиялық араласу жақсы функционалды нәтижелерді және ауырсынудың айқынырақ төмендеуін қамтамасыз етеді. Емдеу әдісін таңдау науқастың жеке ерекшеліктерін және сыну сипаттамаларын ескеруі керек.

Түйін сөздер: кеуде-бел аумағының сынуы, гиперэкстензиялық гипс, қысқа сегментті бекіту, кифотикалық бұрыш, функционалдық нәтиже.

Долгосрочные результаты гиперэкстензионной иммобилизации по сравнению с короткосегментарной фиксацией при переломах грудопоясничного отдела с оценкой TLICS 4

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Резюме

Целью данного исследования было сравнение долгосрочных клинических и рентгенологических результатов консервативного лечения с использованием гиперэкстензионной гипсовой иммобилизации и хирургического лечения (короткосегментарная фиксация) при переломах груднопоясничного отдела позвоночника с оценкой по шкале TLICS = 4.

Методы. Проведен ретроспективный анализ пациентов со стабильными компрессионными переломами на уровне T10–L2, которым в период с 2004 по 2014 гг. выполнялось консервативное лечение гиперэкстензионным гипсом (Группа А, n=28) или хирургическая короткосегментарная фиксация (Группа В, n=36). Оценивались уровень боли (визуально-аналоговая шкала, ВАШ), функциональные результаты (индекс инвалидизации Освестри), локальный кифотический угол (угол Кобба), степень компрессии передней высоты тела позвонка и удовлетворенность пациентов.

Результаты. Между группами не выявлено значимых различий по возрасту, полу, минеральной плотности костной ткани (BMD) и длительности наблюдения. Продолжительность госпитализации была значительно выше в Группе В ($5,1 \pm 2,5$ против $2,1 \pm 0,7$ суток; $p < 0,001$, d Коэна=1,55). По рентгенологическим параметрам (угол Кобба, ACVBN, SI) значимых различий на момент финального наблюдения не выявлено. Однако в Группе В отмечены значительно лучшие показатели по индексу Освестри в отдаленном периоде ($p < 0,001$, d Коэна=1,23), а также по шкале ВАШ — до лечения ($p = 0,047$, d Коэна=0,53), после лечения ($p = 0,024$, d Коэна=0,57) и при последующем наблюдении ($p < 0,001$, d Коэна=1,18). Частота осложнений в обеих группах была сопоставимой.

Выводы. Гиперэкстензионная гипсовая иммобилизация обеспечивает сходные рентгенологические результаты по сравнению с хирургическим лечением, однако хирургическое вмешательство обеспечивает лучшие функциональные исходы и более выраженное снижение болевого синдрома. Выбор метода лечения должен учитывать индивидуальные особенности пациента и характеристики перелома.

Ключевые слова: перелом груднопоясничного отдела, гиперэкстензионный гипс, короткосегментарная фиксация, кифотический угол, функциональный исход.