Original Article

Patient-reported outcomes after posterior surgical stabilization for thoracolumbar junction fractures: A pilot study with combined patient-reported outcome measure methodology

ABSTRACT

Background: Thoracolumbar junction fractures (TLJFs) attract controversy for several parameters, including surgery versus conservative treatment, fusion versus stabilization, open versus percutaneous surgery, construct length, and downstream metalwork extraction.

Aims and Objectives: The aim of this pilot study was to assess the effectiveness of surgical treatment in patients with burst (AO Classification Type A4) TLJFs using patient-reported outcome measures (PROMs) and evaluate and compare different PROMs in this clinical scenario.

Materials and Methods: Patient records of consecutive patients who underwent posterior stabilization surgery for TLJFs were retrospectively reviewed. Data were collected on demographics, medical and social history, neurological examination, and postoperative complications. Telephone interviews and a combined PROM methodology (Numerical Rating Scale [NRS], EuroQol [EQ]-5D-5L, and Oswestry Disability Index [ODI]) were utilized to assess the effectiveness of intervention. Descriptive statistics were used to analyze exposure variables and outcome measures. Spearman's rank correlation was used for the outcome measures.

Results: Thirteen patients were included. The mean age was 42 ± 16 years; the male: female ratio was 8:5; the mean follow-up was 18.9 ± 6.4 months. The mean NRS score was 3.3 ± 2.5, in line with a median score of 2 (2) on EQ-5D-5L pain/discomfort scale. Statistically significant correlations were found between several PROMs: pain-EQ-5D-5L and NRS (rs = 0.8, P = 0.002), pain-EQ-5D-5L and ODI (rs = 0.8, P = 0.001), usual anxiety/depression-EQ-5D-5L, and ODI (rs = 0.7, P = 0.008).

Conclusion: A combined PROM methodology showed supportive evidence for safety and efficacy in the surgical stabilization of burst TLJFs. This alleviated significant pain and prevented neurological deficit and major disability. The preliminary widespread correlation between these PROMs supports further larger studies of their combined use in clinical practice, to measure the outcomes of spine trauma patients.

Keywords: Combined patient-reported outcome measure methodology, patient-reported outcome measures, spine fractures, thoracolumbar junction fractures, visual analog scale

INTRODUCTION

The thoracolumbar junction of the spine (T10-L2) is a zone of transition between the rigid kyphotic thoracic region and the mobile lordotic lumbar region of the spinal column. This junctional area is structurally and biomechanically susceptible to traumatic injury.[1-5] Indeed, fractures in the thoracolumbar junction of the spine account for 90% of fractures in the spinal column.[1,6,7]

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Burst fractures at the thoracolumbar junction, also known as per the AO spine classification as A4 or complete burst,[8] occur due to axial loading through the anterior and middle thirds of the vertebrae. This results in fracturing through the posterior vertebral wall too and retropulsion of bone fragments into the spinal canal. A compromise of the spinal canal diameter can increase the risk of neurological injury.[9]

Fractures in this region are generally classified as stable or unstable. The treatment of stable burst fractures is conservative, such as with an orthosis.[6,7,10] However, in cases where the fractures are deemed unstable, surgical treatment is indicated to prevent further kyphotic deformity, disability, and neurological deficit.[1-3,6,11,12] The surgical treatment options are several and are based on the morphology of the fracture, the neurologic condition of the patient, and the preference of the surgeon.[13] These treatment options, e.g., surgical approach (anterior, posterior, lateral, and combined), implant type, open versus percutaneous surgery, fusion versus stabilization, and length of construct, continue to be the topic of debate and controversy among specialists.[14-17]

Patient-reported outcome measures (PROMs) have been increasingly used to assess the efficacy and cost-effectiveness of spinal treatments.[18-20] There are a variety of PROMs available in the literature; however, three of the most commonly used are the Numerical Rating Scale (NRS), the EuroQol (EQ)-5D-5L, and the Oswestry Disability Index (ODI).[21-23] Although the literature on the subject of thoracolumbar fracture management is extensive, there are very few PROM-related studies.

The primary aim of this study was to use a combined PROM methodology (NRS, EQ-5D-5L, and ODI) to assess the effectiveness of posterior percutaneous surgical stabilization in a cohort of patients who suffered a thoracolumbar junction fracture (TLJF). Furthermore, we aimed to assess the correlation between different PROMs in order to explore the potential significance of their combined use in clinical practice.

MATERIALS AND METHODS

This was a retrospective case series pilot study that was conducted at a single institution. Ethical approval was granted by the home institution of the first author, and oral (during telephone call) informed consent was obtained from all patients and documented using a standardized form.

Patient selection

Fifteen consecutive patients were to be piloted. The inclusion criteria for this study were as follows:

a. Unstable "burst" fractures of the thoracolumbar region (AO spine classification: A4 or complete burst)[8]
b. Surgically treated within 24 h after admission for trauma using a minimally invasive technique of posterior percutaneous instrumented stabilization
c. Operated on by a single surgeon
d. Aged 18 or more years (adults)
e. Able and willing to participate in telephone interviews.

The exclusion criteria included patients with preoperative neurological deficit, incomplete records, unavailability or inability to complete the interview process, and those with concurrent lower extremity injuries which would interfere with outcome measures.

Data collection

Patient-reported outcome measures

All eligible patients were contacted directly by the research coordinator to undertake a telephone interview where a standardized script was used to collect PROMs. Where necessary, a patient was called more than once. The PROMs used were the NRS, the EQ-5D-5L, and the ODI. Although a plethora of PROMs are available enabling the assessment of a wide variety of parameters,[18,24] we elected to use the NRS, the ODI, and the EQ-5D-5L as they are some of the most commonly used and well established in the existing scientific literature.[18,24,25]

The NRS is used to assess patient-reported pain. Patients are asked to rate their level of pain on a scale of 1 to 10, with ten being the highest and one being the lowest. The ODI is used to assess disability in relation to lower back pain. This includes sections on pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sexual function, social life, and ability to travel. The EQ-5D-5L includes six different sections: mobility, self-care, usual activities, pain/discomfort, anxiety/depression, and EQ-Visual Analog Scale (VAS) (similar to the standalone NRS). In addition, the patients were asked if they were currently taking medication to manage their pain and what this was.

All patients gave informed consent for participation in the study.

Patient data

Patient data were collected retrospectively via an electronic records system. This comprised patient baseline demographics, comorbidities, smoking status, clinical examination findings during admission, evidence of neurological deficit, and postoperative complications. Operation-related factors were also collected, including further procedures undertaken.

Surgical treatment

All patients in the pilot were operated on by a single surgeon using the same instrumentation kit. Posterior percutaneous and minimally invasive stabilization was performed using pedicle screws and rods bilaterally; this was consistent through the pilot group. The patients were mobilized as soon as possible after that without a brace.

Statistical analysis

Descriptive statistics were undertaken to analyze exposure variables which included patient characteristics (age, gender, comorbidities, and smoking status) and operation-related factors (follow-up time since operation, further procedures undertaken, and current pain medication). Descriptive statistics were also undertaken for PROM outcome measures. These were presented as percentages and counts for categorical data, as well as means ± standard deviation (SD) for data with normal distributions or medians (interquartile range [IQR]) for data with nonnormal distributions, as per the Shapiro–Wilk test.

The differences in how patient characteristics (gender, smoking status, presence of comorbidities, use of pain medication following surgery, and further procedures) affected different PROM outcomes were analyzed by using the two-sample unpaired *t*-test or the Mann–Whitney *U*-test for data with normal and nonnormal distributions, respectively. The correlation of age and follow-up time on PROM outcomes was assessed via Spearman's rank coefficient (r_s). In addition, Spearman's rank was also used to assess how effectively the PROM outcome measures correlated with one another.

The EQ-5D-5L index was calculated using the SPSS syntax code provided for the EQ-5D-5L (United Kingdom) instrument at the official website of the EQ Group (https://euroqol.org/support/analysis-tools/index-value-set-calculators/, accessed on October 2, 2022).

All statistical analyses were undertaken on IBM SPSS 25, where $P < 0.05$ was considered statistically significant.

RESULTS

In this pilot study, a total of 15 patients were selected to be contacted for telephone interview. One did not fully complete the questionnaires and was excluded. Due to evidence of lower extremity injuries, another patient was also excluded from our study, resulting in 13 patients included in the analysis. The mean age of the patients was 42 ± 16 years, and the male: female ratio was 8:5. Five patients (39%) were smokers and four patients (31%) had comorbidities. Overall, seven patients (54%) were taking pain medication; six of them (86%) were taking opiate-containing medication. Four patients (31%) had further surgery: two because of loosening of the construct requiring a revision, one for a fractured screw, and one for elective removal of the metalwork after healing of the fracture, a choice given to everybody. The mean follow-up time was 18.9 ± 6.4 months.

Patient reported outcome measure scores

The mean NRS score of all the patients was 3.3 ± 2.5, indicating low-to-moderate pain levels in our pilot sample. This was in line with the median score of 2 (2) reported on the EQ-5D-5L pain/discomfort scale. Overall, patients were found to have minimal disability based on the median ODI score of 20 (25.1). This was in line with the mean EQ-5D-5L VAS score of 70 ± 25.4 out of 100. Overall, the mean EQ-5D-5L index score for all patients was 0.8 ± 0.2. Table 1 presents the mean or median scores for all PROMs.

Impact of patient-related factors on patient-reported outcome measure outcomes

There was no statistically significant difference for age, gender, smoking, follow-up time (days since initial operation), and follow-up time (days since revision for those with reoperations) regarding PROM outcomes for NRS, EQ-5D-5L, and ODI [Appendix S1].

Regarding comorbidities, a statistically significant relationship ($P = 0.003$) was identified between the presence of comorbidities and self-care scores of the EQ-5D-5L. Namely, patients with comorbidities (median [IQR] score: 2.5 [1]) experienced greater difficulty in washing and dressing themselves than patients without comorbidities (median [IQR] score: 1 [0]). No statistically significant results were identified with the rest of the PROMs [Table 2].

Pain medication

With regard to NRS scores, patients who were not taking

Table 1: The mean/median scores for all patient-reported outcome measures used

PROM	*n*	Mean±SD/median (IQR)
NRS (0–10)	13	3.3±2.5
EQ-5D-5L VAS (1–100)	13	70±25.4
EQ-5D-5L mobility	13	2 (2)
EQ-5D-5L self-care	13	1 (1)
EQ-5D-5L usual activities	13	2 (2)
EQ-5D-5L pain/discomfort	13	2 (2)
EQ-5D-5L anxiety/depression	13	1 (1)
EQ-5D-5L index	13	0.8±0.2
ODI (%)	13	20 (25.1)

PROM-Patient-reported outcome measure; SD-Standard deviation; IQR-Interquartile range; NRS-Numerical Rating Scale; ODI-Oswestry Disability Index; VAS-Visual Analog Scale; EQ-EuroQol

pain medication reported statistically significant ($P < 0.001$) lower levels of pain (mean [SD] score: 1.2 ± 1.2) than those who were (mean [SD] score: 5.1 ± 1.8). This correlates well with the pain/discomfort portion of the EQ-5D-5L, where once again patients not taking pain medication reported statistically significant ($P = 0.02$) lower scores on average (median [IQR] score: 1.5 [1]) than their counterparts (median [IQR] score: 3 [1]).

A statistically significant ($P < 0.05$) higher EQ-5D-5L index was identified in patients who were not taking pain medication (mean [SD] index: 0.92 ± 0.1) when compared to those that did (mean [SD] index: 0.7 ± 0.2). Similarly, patients not taking pain medication also showed statistically significant ($P = 0.04$) higher levels of general health, as demonstrated by their EQ-VAS scores. These patients had a higher mean EQ-VAS score of 85 ± 19.5 in comparison to patients on pain medication (57.1 ± 23.6). This was further supported by the ODI findings, where a statistically significant ($P = 0.003$) greater disability was observed in those taking pain medication (median [IQR] percentage: 24 [40]) compared to those who did not (median [IQR] percentage: 8.9 [18.5]). Those taking pain medication also had more difficulty ($P < 0.05$) in doing their usual activities (EQ-5D-5L usual activities median [IQR] score: 3 [3]) than those who did not take pain medication (EQ-5D-5L usual activities median [IQR] score: 1 [1]).

Table 3 summarizes the results of the analysis regarding the effects of pain medication on PROM outcomes.

Correlation between patient-reported outcome measures

A statistically significant negative correlation was found between the EQ-5D-5L index and the NRS ($r_s = -0.8$, $P = 0.002$) and ODI ($r_s = -0.8$, $P = 0.002$) scores, indicating lower pain and disability levels in patients with higher EQ-5D-5L index scores. Furthermore, a statistically significant correlation was found between the pain scores (EQ-5D-5L) with NRS and ODI scores. A positive correlation was shown between the NRS rating and the pain dimension of the EQ-5D-5L ($r_s = 0.8$, $P = 0.002$). This was also true for the EQ-5D-5L pain and the ODI scores ($r_s = 0.8$, $P = 0.001$), reflecting that greater pain scores attributed to a greater level of disability. This was further reinforced by the positive correlation between NRS scores and ODI ($r_s = 0.8$, $P = 0.001$).

There was also a positive correlation between NRS and the usual activity dimension of the EQ-5D-5L ($r_s = 0.8$, $P = 0.001$), where those with higher pain scores reported greater difficulty undertaking their day-to-day activities. The results also suggest that patients with a greater degree of disability (on the ODI) were also much more prone to being anxious and depressed (EQ-5D-5L anxiety/depression) ($r_s = 0.7$, $P = 0.008$). This correlation was also present between the NRS score and the anxiety/depression dimension of the EQ-5D-5L ($r_s = 0.6$, $P = 0.04$).

Table 4 summarizes the results of the analysis regarding the correlation between the various PROMs.

Table 2: Summary of *P*-values for effect of comorbidities on patient-reported outcome measure outcomes

PROM	*P*
NRS (0–10)	0.53
EQ-5D-5L VAS	0.64
EQ-5D-5L mobility	0.23
EQ-5D-5L self-care	**0.003**
EQ-5D-5L usual activities	0.37
EQ-5D-5L pain/discomfort	0.25
EQ-5D-5L anxiety/depression	0.12
EQ-5D-5L index	0.16
ODI	0.24

Bold and underline indicates statistical significance. PROM-Patient-reported outcome measure; NRS-Numerical Rating Scale; ODI-Oswestry Disability Index; VAS-Visual Analog Scale; EQ-EuroQol

Table 3: Summary of *P*-values for effect of the use of pain medication on patient-reported outcome measure outcomes

PROM	*P*
NRS (0–10)	**<0.001**
EQ-5D-5L VAS	**0.04**
EQ-5D-5L mobility	0.27
EQ-5D-5L self-care	0.12
EQ-5D-5L usual activities	**<0.05**
EQ-5D-5L pain/discomfort	**0.02**
EQ-5D-5L anxiety/depression	0.08
EQ-5D-5L index	<0.05
ODI	**0.003**

Bold and underline indicates statistical significance. PROM-Patient-reported outcome measure; NRS-Numerical Rating Scale; ODI-Oswestry Disability Index; VAS-Visual Analog Scale; EQ-EuroQol

DISCUSSION

The primary aim of this study was to use the outcome measures of ODI, NRS, and the EQ-5D-5L to understand the efficacy of surgical stabilization treatment in TLJFs. In our cohort of patients, the treatment of thoracolumbar fractures resulted in good postoperative pain control. In addition, our patients displayed higher levels of disability and lower levels of perceived general health than the general population, as expected after spinal trauma. Most importantly, due to the unstable nature of these fractures, surgery was a necessity. Therefore, we can state that the intervention was able to prevent substantial disability and neurological deficit which may have rendered our patients immobile and caused worse functional outcomes.

Table 4: The correlation between the various PROMs. PROMs - Patient-reported outcome measures

Statistical test	PROM	NRS	EQ VAS (EQ-5D-5L)	Pain (EQ-5D-5L)	Self-care (EQ-5D-5L)	Anxiety/ depression (EQ-5D-5L)	Mobility (EQ-5D-5L)	Usual activities (EQ-5D-5L)	EQ-5D-5L index	ODI
Spearman's rho	NRS	1	-0.5	0.8	0.5	0.6	0.6	0.8	-0.8	0.8
	Significance (*P*)		0.07	0.002	0.09	0.04	0.03	0.001	0.002	0.001
	EQ VAS (EQ-5D-5L)	-0.5	1	-0.5	-0.2	-0.6	-0.4	-0.6	NA	-0.6
	Significance (*P*)	0.07		0.1	0.5	0.04	0.2	0.04		0.04
	Pain (EQ-5D-5L)	0.8	-0.5	1	NA	NA	NA	NA	NA	0.8
	Significance (*P*)	0.002	0.1							0.001
	Self-care (EQ-5D-5L)	0.5	-0.2	NA	1	NA	NA	NA	NA	0.5
	Significance (*P*)	0.09	0.5							0.09
	Anxiety/depression (EQ-5D-5L)	0.6	-0.6	NA	NA	1	NA	NA	NA	0.7
	Significance (*P*)	0.04	0.04							0.008
	EQ-5D-5L index	-0.8	NA	NA	NA	NA	NA	NA	1	-0.8
	Significance (*P*)	0.002								0.002
	Mobility (EQ-5D-5L)	0.6	-0.4	NA	NA	NA	1	NA	NA	0.6
	Significance (*P*)	0.03	0.2							0.03
	Usual activities (EQ-5D-5L)	0.8	-0.6	NA	NA	NA	NA	1	NA	0.7
	Significance (*P*)	0.001	0.04							0.004
	ODI	0.8	-0.6	0.8	0.5	0.7	0.6	0.7	-0.8	1
	Significance (*P*)	0.001	0.04	0.001	0.09	0.008	0.03	0.004	0.002	

The patients in our study reported a median ODI score of 20, suggestive of moderate disability. In their analysis of published studies, Fairbank and Pynsent found that the mean ODI score of the "healthy" population was 10.19.[21] Comparatively, our patients endured greater levels of disability after spinal trauma and its treatment. We cannot be precise as to the extent to which surgical stabilization was effective due to variable ODI scores, ranging between 0 and 76, and due to the absence of preoperative scores. However, our results, showing an absence of bed-bound patients postoperatively, suggest that surgical stabilization prevented significant disability in our patients. A recent study by Saravi *et al*. illustrated that minimally invasive thoracolumbar fracture stabilization translated into improved patient-reported outcomes across the entire range of used PROMs (ODI, EQ-5D, Core Outcome Measures Index, and NRS).[26] In a similar fashion, a study comparing surgical versus conservative treatment for traumatic TLJFs with a score of 4 on the Thoracolumbar Injury Classification and Severity Score System (TLICS) identified statistically significant better ODI scores in the surgical group throughout the 2-year follow-up period.[27] In contrast, however, in another study, Nataraj *et al*. did not find any differences in the outcomes (ODI, Short Form-12, and VAS) of TLICS 4 burst fracture patients treated surgically versus those treated conservatively.[28]

Interestingly, our study found no correlation between the PROMs and smoking status, gender, or age. Mixed data exist about the association of these factors in the overall spinal literature.[29-31] For example, a large-scale study by Strömqvist *et al*. showed that older patients reported inferior PROM scores postoperatively, with less improvement in functional outcomes.[30] On the contrary, other studies in patients with thoracolumbar fractures[26] and other lumbar pathologies[32] have identified younger age to be significantly correlated with worse postoperative patient-reported outcomes. The lack of correlation in our study can be attributed to either differences in the conditions studied (trauma versus disc degeneration) or the small sample size in our study. Furthermore, it should be noted that patient satisfaction is complicated and multifaceted, and depends not only on medical facts but also on previous experiences and socioeconomic status.[33] The same stands as regards the effect of smoking, generally believed to be a negative prognostic factor in the spine literature.[34-38]

While it has been established that comorbidities increase the risk of complications in spinal surgery,[39,40] the extent to which comorbidities affect patient outcomes is rather complex. Previous studies have found that comorbidities can lead to variability in PROMs,[39,41] specifically in relation to functional outcomes in spinal disorders.[41] This supports our findings that patients with comorbidities reported higher self-care scores (i.e., needs) which suggest a reduced functional outcome. In agreement with our findings, a recently published retrospective study in patients treated surgically for traumatic thoracolumbar fractures reported poorer functional outcomes (ODI and Short Form-36) in those with comorbidities.[42] Large-scale research with subanalysis of comorbidities is necessary to differentiate between the

impact different comorbidities may have on postoperative outcomes. For example, might a patient with osteoporosis have a worse outcome than a patient with heart disease after spinal surgery?

Our study also reinforces the importance of considering the impact of pain medication on clinical outcomes.[43] Patients who were not on pain medication reported lower pain scores overall, higher levels of general health, and lower levels of disability. While this is self-explanatory, the impact of pain medication on patient perception of pain and their health is important to consider. Due to our small sample size, analyses of differences in dosage and type of pain medication on PROMs could not be undertaken. This is something that needs to be addressed due to the variable pharmacokinetic effects of different medications. On the other hand, PROMs could evolve to incorporate the use of pain medication into the assessment of their pain scores.[43]

Among our pilot group, some patients had further surgery. Previous literature has shown that patients who undergo further procedures have comparable outcomes to those who have not.[44,45] Hassanzadeh *et al*. showed that patients who underwent further procedures had better self-image and mental health.[44] Our findings, within the limitations of the sample size, suggest that those who had undergone further procedures did not have different functional outcomes when compared to those that had not. We believe, however, that patient outcomes should ideally be assessed after both primary and revision surgeries to effectively differentiate the efficacy of each surgical intervention.

Our results, similarly to other studies,[29] largely support the combined use of the NRS, ODI, and EQ-5D-5L in clinical practice. This was primarily shown by our significant correlation between NRS and ODI which strongly signified that with a greater level of pain comes a greater level of disability. Although NRS and ODI did not always correlate with EQ-VAS, this may be due to how patients interpreted EQ-VAS. The EQ-VAS could have been interpreted as a measure of general health, whereas the NRS and ODI were answered specifically about back pain and disability alone. When it came to ODI scores, as our results show, they correlate strongly with four dimensions of the EQ-5D-5L: pain, anxiety/depression, self-care, and usual activities. This supports previous studies which show a strong correlation between ODI and EQ-5D-5L.[45]

To undertake this study, multiple PROMs were implemented because no specific PROM exists for spinal trauma. The EQ-5D-5L addressed aspects of mental health that the ODI and NRS did not. For patients, this was a time-consuming and repetitive process, with significant overlap in questions relating to pain and mobility. It would not be time and cost-effective to undertake multiple PROMs in a clinical setting. Bernstein *et al*. proposed the use of the Patient-Reported Outcomes Measurement Information System (PROMIS) in spinal trauma as an alternative to PROMs. Their study found that when compared to ODI, PROMIS allowed greater exploration into mental health issues and functional limitations not captured by the ODI.[46] PROMIS is a widely validated outcome measure, showing a strong correlation to existing legacy PROMs widely used in spinal surgery.[46,47] PROMIS offers a standardized assessment of physical, mental, and social health, allowing for comparisons across a range of musculoskeletal or spine diseases.[46] Therefore, PROMIS could potentially be applied in further studies on thoracolumbar fractures as a comprehensive and time-effective solution in assessing patient outcomes.

Considerations and limitations

While assessing outcomes with a single surgeon can have the advantage of consistency, it has limitations. Different surgeons will have varied surgical experience and expertise, and consequently, this may impact on functional outcomes. Therefore, we could not and did not try to distinguish whether outcomes were due to the efficacy of the instrumentation alone or due to surgical technique. To minimize bias, a larger sample size and multiple surgeons at multiple centers would be the ideal in further studies beyond this pilot. The relatively small sample size was intentional in order to pilot the usefulness and reliability of different PROMs in this group of patients. It should be noted that the age range of the included patients was wide; it could be helpful if future studies focused on specific populations (e.g., the elderly, young adults, and middle-aged adults); however, we approached this pilot group as it pragmatically presented.

Retrospective studies have well-known limitations. In addition, doing a retrospective analysis meant that some key patient demographics (e.g., body mass index) were not available. Therefore, we did not assess the quality of life retrospectively to avoid recall bias.

As our PROMs were only collected postoperatively, without a preoperative control measurement, we could not fully assess the efficacy of surgical intervention. Pretreatment PROMs in relation to thoracolumbar fractures would be ideal, though they are understandably not always practical. Therefore, we believe that this pilot study provides enough support for further specific prospective research comparing pre- and postoperative outcomes. In this study group, most unstable

burst fractures occurred due to significant trauma, and it was not pragmatic to have obtained this information.

No control group was designated. Consequently, we cannot fully understand if the treatment received is advantageous over others in treating thoracolumbar fractures; we can only judge its safety and efficacy in the treatment provided.

Our study encompassed fractures at different levels of the thoracolumbar region. Injuries at different levels of the spinal column may influence the significance of the injury and interpretation of pain.[4] Therefore, a larger sample group where subanalysis of fracture level may be of benefit, though it seems that we are consistent with the literature in that fractures of the thoracolumbar region are treated as a group.

CONCLUSION

Despite the vast literature on thoracolumbar fracture management, there are very few PROM-related studies. We have utilized a combined PROM methodology (with NRS, ODI, and EQ-5D-5L) to show that at an average of 18.9 months, and with a mean VAS of 3.3 and ODI of 20, there is supportive evidence for a widespread correlation between the PROMs studied, which supports their combined use in clinical practice. Furthermore, this study demonstrates that factors such as comorbidities, use of pain medication, and further procedures influence PROM outcomes. Therefore, the application of PROMs in deciding the efficacy of surgical intervention ought to be cautiously explored further.

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Conflicts of interest
There are no conflicts of interest.

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APPENDIX S1

Appendix S1a: Summary of *P*-values for effect of gender on patient-reported outcome measure outcomes

PROM	*P*
NRS (0–10)	0.59
EQ-5D-5L VAS (1–100)	0.32
EQ-5D-5L mobility	0.09
EQ-5D-5L self-care	0.24
EQ-5D-5L usual activities	0.09
EQ-5D-5L pain/discomfort	0.35
EQ-5D-5L anxiety/depression	0.77
EQ-5D-5L index	0.13
ODI (%)	0.83

PROM-Patient-reported outcome measure; NRS-Numerical Rating Scale; ODI-Oswestry Disability Index; VAS-Visual Analog Scale; EQ-EuroQol

Appendix S1b: Summary of *P*-values for effect of age on patient-reported outcome measure outcomes

PROM	r_s (*P*)
NRS (0–10)	−0.27 (0.37)
EQ-5D-5L VAS (1-100)	0.39 (0.19)
EQ-5D-5L mobility	−0.09 (0.78)
EQ-5D-5L self-care	0.13 (0.69)
EQ-5D-5L usual activities	−0.38 (0.21)
EQ-5D-5L pain/discomfort	−0.35 (0.24)
EQ-5D-5L anxiety/depression	−0.23 (0.46)
EQ-5D-5L index	0.15 (0.62)
ODI (%)	−0.35 (0.25)

PROM-Patient-reported outcome measure; r_s-Spearman's rank coefficient; NRS-Numerical Rating Scale; ODI-Oswestry Disability Index; VAS-Visual Analog Scale; EQ-EuroQol

Appendix S1c: Summary of *P*-values for effect of smoking on patient-reported outcome measure outcomes

PROM	*P*
NRS (0–10)	0.79
EQ-5D-5L VAS (1–100)	0.57
EQ-5D-5L mobility	0.57
EQ-5D-5L self-care	0.56
EQ-5D-5L usual activities	0.48
EQ-5D-5L pain/discomfort	0.64
EQ-5D-5L anxiety/depression	0.02
EQ-5D-5L index	0.37
ODI (%)	0.56

PROM-Patient-reported outcome measure; NRS-Numerical Rating Scale; ODI-Oswestry Disability Index; VAS-Visual Analog Scale; EQ-EuroQol

Appendix S1d: Summary of *P*-values for effect of the follow-up time on patient-reported outcome measure outcomes

PROM	r_s (*P*)
NRS (0–10)	−0.29 (0.33)
EQ-5D-5L VAS (1–100)	0.22 (0.46)
EQ-5D-5L mobility	−0.45 (0.12)
EQ-5D-5L self-care	−0.27 (0.37)
EQ-5D-5L usual activities	−0.43 (0.14)
EQ-5D-5L pain/discomfort	−0.32 (0.29)
EQ-5D-5L anxiety/depression	−0.02 (0.94)
EQ-5D-5L index	0.37 (0.21)
ODI (%)	−0.43 (0.14)

PROM-Patient-reported outcome measure; r_s-Spearman's rank coefficient; NRS-Numerical Rating Scale; ODI-Oswestry Disability Index; VAS-Visual Analog Scale; EQ-EuroQol

Appendix S1e: Summary of *P*-values for effect of the follow up time on patient-reported outcome measures outcomes (follow-up time after revision for patients with reoperations)

PROM	r_s (*P*)
NRS (0–10)	0.41 (0.17)
EQ-5D-5L VAS (1–100)	−0.23 (0.45)
EQ-5D-5L mobility	0.11 (0.71)
EQ-5D-5L self care	0.21 (0.49)
EQ-5D-5L usual activities	0.12 (0.70)
EQ-5D-5L pain/discomfort	0.17 (0.57)
EQ-5D-5L anxiety/depression	0.18 (0.55)
EQ-5D-5L index	−0.08 (0.81)
ODI (%)	0.03 (0.91)

PROM - Patient-reported outcome measures; r_s - Spearman's rank coefficient; NRS - Numerical Rating Scale; ODI - Oswestry disability index