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Impact of different surgical and non-surgical interventions on health-related quality of life after thoracolumbar burst fractures without neurological deficit: protocol for a comprehensive systematic review with network meta-analysis

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ABSTRACT

Introduction There is no international consensus on how to treat thoracolumbar burst fractures (TLBFs) without neurological deficits. The planned systematic review with network meta-analyses (NMA) aims to compare the effects on treatment outcomes, focusing on midterm health-related quality of life (HRQoL).

Methods and analysis We will conduct a comprehensive and systematic literature search, identifying studies comparing two or more treatment modalities. We will search MEDLINE, EMBASE, Google Scholar, Scopus and Web of Science from January 2000 until July 2023 for publications. We will include (randomised and non-randomised) controlled clinical trials assessing surgical and non-surgical treatment methods for adults with TLBF. Screening of references, data extraction and risk of bias (RoB) assessment will be done independently by two reviewers. We will extract relevant studies, participants and intervention characteristics. The RoB will be assessed using the revised Cochrane RoB V.2.0 tool for randomised trials and the Newcastle-Ottawa Scale for controlled trials. The OR for dichotomous data and standardised mean differences for continuous data will be presented with their respective 95% CIs. We will conduct a random-effects NMA to assess the treatments and determine the superiority of the therapeutic approaches. Our primary outcomes will be midterm (6 months to 2 years after injury) overall HRQoL and pain. Secondary outcomes will include radiological or clinical findings. We will present network graphs, forest plots and relative rankings on plotted rankograms corresponding to the treatment rank probabilities. The ranking results will be represented by the area under the cumulative ranking curve. Analyses will be performed in Stata V.16.1 and R. The quality of the evidence will be evaluated according to the Grading of Recommendations, Assessment, Development and Evaluations framework.

Ethics and dissemination Ethical approval is not required. The research will be published in a peer-reviewed journal.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Patient-relevant outcomes in the form of overall health-related quality of life (HRQoL) and HRQoL domains are assessed as primary outcomes in a comprehensive literature review.
⇒ Grading of Recommendations Assessment, Development and Evaluation will be used to assess the quality of the evidence, provide comprehensive suggestions and enable the determination of the superiority of one therapy approach over the other.
⇒ Our results will be limited by the quantity and quality of eligible studies included.

INTRODUCTION

Spine injuries are a pressing healthcare problem with a large individual and socio-economic impact. The incidence, prevalence and years lived with disability of vertebral fractures have increased worldwide from 1990 to 2019.[1] A spinal injury can severely impact the affected person's daily life, with a risk for midterm and long-term adverse impacts on their health-related quality of life (HRQoL).[2] This particularly affects overall HRQoL, pain, physical function and mental health impairments.[2]

A thoracolumbar burst fracture (TLBF) is the most frequent spinal injury.[3 4] About 30%–50% of all patients with a TLBF remain neurologically intact.[5] At the thoracolumbar transition, the essentially rigid thoracic spine meets the very mobile lumbar spine. This transition area is particularly at risk for fractures.[4 6] The most common unstable fracture in this area is the burst fracture.

Burst fractures are responsible for about 15% of spinal injuries.[6]

There is no clear recommendation for the treatment of TLBF with intact neurology.[7–9] The authors report good outcomes with both non-operative treatment and operative care. With operative care, proponents believe that reduction and stabilisation of the fracture are essential for rapid recovery, return to work, social function and pain relief.[10 11] Furthermore, there is controversy about the timing of the surgery, the approach and whether the fusion needs to be stabilised posteriorly only, anteriorly only or combined dorsoventrally.[12] In our clinical practice, in a Level 1 trauma centre, these fractures tend to be treated surgically with a complete short-segment fusion of the affected vertebra (360° fusion).[13]

Due to the heterogeneity and inconclusiveness of the existing literature, which offers varying recommendations and proposes multiple treatment algorithms, there is a pressing need for a comprehensive analysis.[5 14 15] Despite the presence of three dated yet comprehensive reviews exploring surgical and non-surgical approaches, it is essential to undertake a contemporary examination of the evidence. For instance, Verlaan *et al* provided an in-depth assessment of surgical interventions for TLBF in 2004, encompassing insights from a substantial pool of 132 clinical trials.[16] They grouped the treatments into five subgroups, that is, posterior short segment, posterior long segment, both posterior (short segment and long segment) and anterior (short segment and long segment) and anterior combined with posterior techniques. Bakhsheshian *et al*[17] and Scheer *et al*[18] analysed 45 clinical trials of non-surgical management and 23 clinical trials of surgical management in 2014 and 2015, respectively. While imaging findings are very important to the treating physician, quality of life is not always reflected in radiographs. Thus, a literature review should be guided by patient-centred outcomes.[19]

Therefore, this study aims to compare conservative and surgical interventions in patients with TLBF without neurological deficits using data from non-randomised controlled clinical trials and randomised controlled trials (RCTs) to determine which treatment is most effective in improving HRQoL overall and in its domain measured as medium-term quality of life (6 months up to 2 years). This should lead to greater certainty in treatment choice by comparing the individual methods and should ultimately help establish treatment guidelines.

Objective

We will aim to quantify the impact of different surgical and non-surgical treatment approaches on midterm HRQoL in treating TLBFs without neurological deficits.

METHODS AND ANALYSIS

Design

This protocol was prepared following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocol statement.[20] Any changes to this protocol will be updated accordingly.

Information sources and search strategy

Electronic searches

We will search the following databases for a comprehensive and sensitive search strategy: MEDLINE (via OvidSP), EMBASE (via OvidSP), Google Scholar and Web of Science as advised by Bramer *et al*[21] and, additionally, Scopus and Cochrane Central Register of Controlled

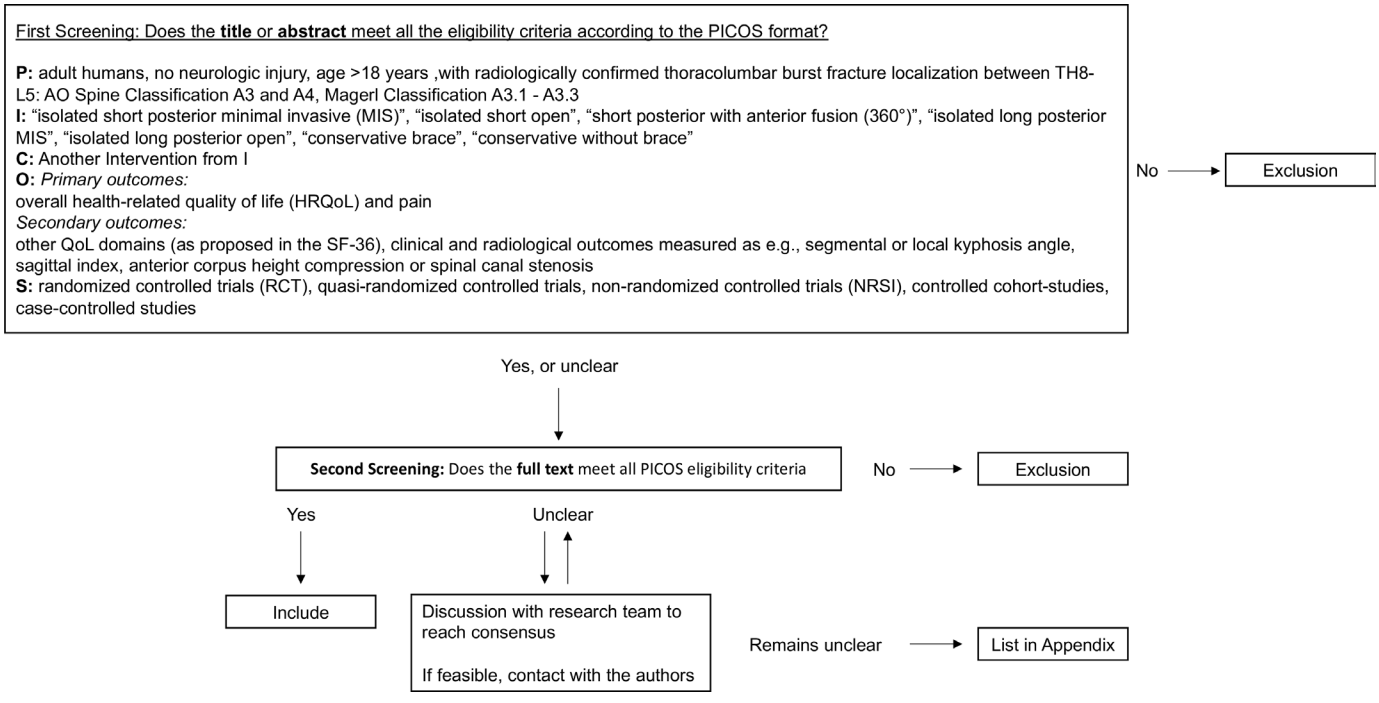

Figure 1 Patient, Intervention, Comparison and Outcome model.

Table 1 Treatment procedures

Isolated short posterior MIS	MIS only adjacent fracture segments fixed
Isolated short open	Open surgery only adjacent fracture segments fixed
Short posterior with anterior fusion (360°)	Anterior and posterior fusion only adjacent fracture segments fixed
Isolated long posterior	MIS two levels above fracture and two levels below fixed
Isolated long posterior open	Open surgery two levels above fracture and two levels below fixed
Conservative brace	Non-surgical therapy Wearing a brace
Conservative no brace	Non-surgical therapy Any but not wearing a brace

MIS, minimally invasive surgery.

Trials (CENTRAL) as recommended by the Cochrane Handbook.[22] The Patient, Intervention, Comparison and Outcome model[23] is used to define the research question and develop the search strategy (figure 1). The planned search queries for all databases are shown in online supplemental material 1. No language restriction will be applied. We will only include articles published from January 2000, as there was a substantial leap forward in terms of implants and techniques and because surgical techniques are constantly evolving, and older studies may not reflect current clinical reality. The end of the search will be in July 2023.

Reference lists and other sources

Reference lists of all included studies, relevant systematic reviews and meta-analyses will be screened manually for eligible additional studies to be included.

Eligibility criteria

Types of participants

We will only include adult patients (>18 years) with an acute (<3 weeks) TLBF (Th10–L3, ie, AO Spine Classification A3 and A4, respectively, Magerl Classification A3.1–A3.3[24]) of the spine without a diagnosed neurological deficit after the fracture. We will focus on acute fractures (<3 weeks) for homogeneity in the study population. Our restriction to burst fractures excludes pathological fractures, especially osteoporotic fractures, which are classified differently (an additional pathological fracture is an exclusion criterion); thus, the study population will be restricted to traumatic TLBF.

The lower age limit was implemented as the treatment of paediatric TLBF differs for multiple biomechanical reasons from the adult fracture (eg, greater flexibility of the osseous structures, thicker periosteum and dense annular fibres of the disc structures in the spine, which allow for greater distribution of forces in younger children).[25]

Types of interventions

There are various methods for the treatment of TLBF. To obtain our treatment groups, we considered already published reviews in combination with a forward search on controlled clinical trials on other surgical treatments of TLBF.[18 19] The different treatment procedures will be grouped into seven categories that form the nodes for our network analysis. These consist of the following five surgical treatment techniques and two non-surgical treatment approaches (table 1). The surgical techniques are divided by the minimally invasive surgical approach and the method of fixation used (figure 2).

To ensure a coherent and precise network under the similarity, transitivity, and consistency assumption and the present evidence, we will perform finer and coarser grouping of the treatment depending on the number of studies found (online supplemental material 2).

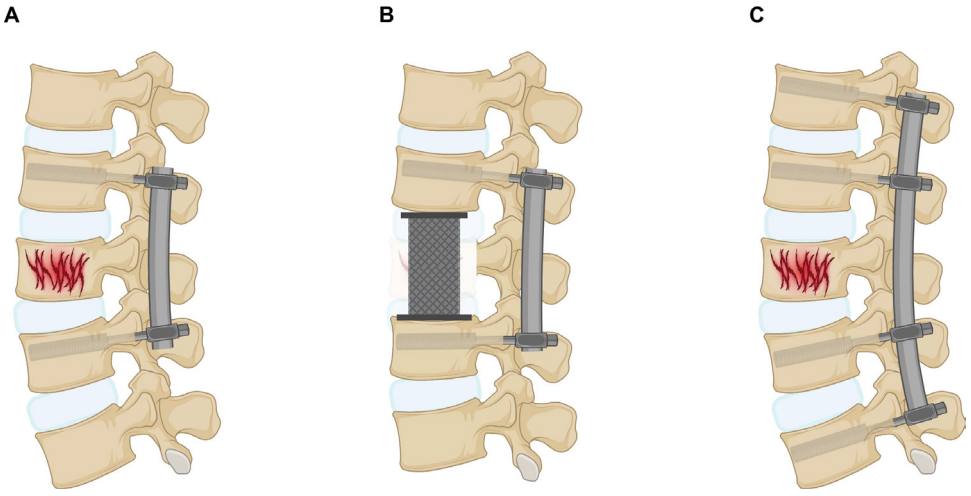

Figure 2 Schematic summary of the surgical techniques used in the treatment of thoracolumbar burst fractures as a basis for the nodes in our network meta-analysis. (A) This demonstrates 'short posterior' fusion surgery, where only the adjacent segments are fused. (B) In addition to the short posterior fixation, a cage implant is inserted from an additional ventral surgical approach (360° fusion). (C) Fixation of more than the adjacent vertebral segments with an internal fixator results in 'long segment posterior' fixation. Figure created with BioRender.com.

Outcome measures

HRQoL is a conceptualisation reflecting an individual's physical and mental well-being. It has become an important factor in the treatment of diseases[26] and reflects the comprehensive well-being of the patient.[26] The focus will be on the midterm quality of life, but all available time points will be extracted. We will group the outcome data into immediate (meaning the survey time point is immediately postoperative until 6 weeks after the operation), short term (the survey time point is 6 weeks to 6 months), midterm (the survey time point is 6 months to 2 years) and long term (the survey time point is 2 years or longer). To reduce the heterogeneity attributable to the measured variables, HRQoL is synthesised according to the quality of life instruments. This study's primary outcome will be overall HRQoL and pain.[27 28]

Network meta-analysis (NMA) will be performed for the primary outcome. The following core outcome measurement instruments (HRQoL) will be considered as the primary outcome in the review:

- Overall HRQoL: SF-36[29] (overall score, physical component summary subscore and mental component summary subscore) or SF-12[30] (overall score, physical component summary subscore and mental component summary subscore), EQ-5D,[31] GQOL-74[32] and LBOS[33]; rating scale from a composite measure of HRQoL; other measurement tools declared as a measurement of overall HRQoL by the respective study's authors. If only an overall score for the SF-36 is provided, we will contact authors for the physical and mental component summary subscores.
- Pain: for example, numeric pain rating scale; 100 mm visual analogoue scale (VAS)[34]; 10 cm VAS; rating scale for pain intensity from a composite measure of pain intensity and other measurement tools.

All outcome measures that are grouped by the screening members of the research group into one of these domains are included.

The secondary outcomes of this review are radiological or clinical findings, that is,

- Segmental kyphosis angle (Cobb angle): cranial and caudal endplates of the cranial and caudal adjacent vertebrae.
- Local kyphosis angle: cranial and caudal endplates of the vertebrae.
- Sagittal index: Cobb angle at the fractured motion segment level minus the normal contour (baseline values: 5° thoracic, 0° thoracolumbar and 10° lumbar).
- Anterior corpus height compression.
- Spinal canal stenosis: estimated percentage loss of spinal canal area compared with the physiological size.
- Other quality of life domains as proposed by the SF-36.[29]
  - Mental health.
  - Physical function.
  - Vitality.
  - Physical role functioning.
  - Emotional role functioning.
  - Social role functioning.

Types of studies

For a comprehensive systematic review, we will include all controlled study designs, that is, RCT, quasi-RCTs, non-RCT, that is, controlled cohort and case-control studies. Including both RCTs and non-RCTs in the NMA can improve accuracy, allow consideration of a broader range of treatments and provide real-world and more generalisable insights into the risks and benefits of medical treatments.[35 36] However, as there are also justified recommendations to restrict an NMA to RCT-only,[37] we plan to address this by (1) discussing our results of the primary analysis in light of this limitation and (2) conducting an RCT-only subgroup analysis for the primary outcomes. We will include trials without language restrictions. If any articles are identified that are reported in languages other than English, Spanish, German or French, we will seek support from the authors' institutions to produce translations. We will only include articles published from January 2000, as there was a substantial leap forward in terms of implants and techniques and because surgical techniques are constantly evolving and older studies may not reflect current clinical reality. We will only include studies providing at least one HRQoL domain (overall, physical function, pain and mental health) as a midterm outcome according to our definition. Studies that do not provide such measures of HRQoL in the study groups will be excluded.

Study selection

The identified references will be screened independently by two reviewers. The studies will be assessed in two steps: first based on the information in the title and abstract, and then based on the full text. Differences in the decisions of the two researchers in all steps will be resolved by discussion and the involvement of a third researcher.

Data extraction

Study characteristics from reports of each study will be managed using a predefined and piloted Microsoft Excel form. Disagreements concerning the data collection process will be solved in the same way as for inclusion decisions. The following data items are planned to be collected: characteristics of the studies (eg, author, title, year, study design and sample size), characteristics of the study population (eg, age and sex), characteristics of the intervention and the control group (eg, operation technique, additional interventions and details of the comparison), outcome data (eg, HRQoL, radiological and other clinical outcomes) and further information that is relevant to judge the risk of bias (RoB). All the data will be independently retrieved by two reviewers. If necessary, we will attempt to contact the original investigators to request missing data, for example, via email with two emails 2 weeks apart. If this is not possible, the measure of effect size as shown by the authors will be

used for descriptive analysis, but the study will not be part of a pooled analysis regarding the specific outcome. If the results of outcome parameters are available from graphic representations only, the relevant values will be extracted using the programme Plot Digitizer V.2.6.4 for MacOSX. The principles of intention-to-treat analyses will be followed as far as possible for dichotomous and continuous outcomes.

RoB assessment

The Cochrane RoB tool, RoB2.[38] will be used for the assessment of the RoB in randomised trials. This instrument includes the following categories: (1) bias due to the randomisation process, (2) bias due to variation in planned interventions, (3) bias due to incomplete outcome data, (4) bias in the measurement of outcomes and (5) bias in the selection of reported outcomes. Each category is rated and classified as 'low', 'high' or 'moderate' in terms of bias. The overall classification of bias is called 'low RoB' if the work is rated 'low risk' in all categories, 'moderate RoB' if at least one category is rated 'moderate concern' and 'high RoB' if at least one category is rated 'high risk' or if several categories are rated 'moderate concern'.

The inclusion of non-RCT studies requires special attention to bias to produce a robust NMA.[22] The RoB in non-randomised studies of interventions will be assessed through the Newcastle-Ottawa Scale tool.[39] This scale allocates four points for the quality of selection, two points for comparability and three points for the quality of outcome and adequacy of follow-up, resulting in a maximum score of nine points.

Two independent evaluators will perform the RoB, which will be piloted before assessing the RoB in the selected studies. Disagreement will be discussed and resolved by involving a third research group member. Entries assessed for RoB will be used to assign study results to judgments of low, high or unclear risk.

The risk of bias assessment will also be used to evaluate the certainty of the evidence. In cases of high certainty and a ≥50% contribution of the direct estimate, the NMA estimate will be evaluated by the choice of the direct estimate, the most contributing estimate or the highest rated estimate of the direct or indirect evidence and additionally by assessing incoherence and imprecision.[23]

Other potential biases, such as the source of funding and conflict of interest of the authors of the included studies, will be considered additionally.

Quality of evidence

The RoB assessment will also be used to evaluate the certainty of the evidence. In addition to this domain, the application of the Grading of Recommendations, Assessment, Development and Evaluations (GRADE)[40] approach (according to the grade working group) considers the assessment of inconsistency, indirectness and publication bias for the direct estimate.

Data synthesis

Quantitative analysis will be performed in R (the R Project, V.4.2.2.) and Stata V.16.1 (StataCorp, The College Station, TX, USA). We will summarise the characteristics of the study, the number of patients and the information concerning the treatment option descriptively. When quantitative analysis is not possible, we will describe the results narratively.

All outcome measures of interest will be scaled for the data synthesis to achieve a uniform scale.

We will extract both effect sizes and measures of central tendencies with spread. The mean differences with a 95% CI or SD will be extracted or calculated for each study group comparison, HRQoL outcome and time point. If the overall HRQoL score is divided into domains, the physical component summary subscore and mental component summary subscore are used for the analysis. As we will have data in different units, we will express the mean difference in units of SD, the so-called standardised mean difference (SMD). The SMD, also called Cohen's d, is defined by the difference of the means divided by the pooled SD. The OR of binary variables will also be converted to effect size and SMD using the method described by Chinn.[41] If the study reports the same value with more than one scale or provides multiple measures for an outcome at a given time point, a pooled estimate will be calculated using a fixed-effects model first. Whenever possible, we aim to extract all possible SMD at any given time point. Measures of central tendencies are extracted (median and mean) for continuous outcomes together with measures of spread (SD, SE, 95% CI and IQR). The SD will be calculated whenever necessary and possible, for example, using Wan's method.[24] If no data to calculate the effect size with spread is available in a trial, we will impute a value using imputation strategies as described in the Cochrane Collaboration Handbook.[38] When studies report multiple time points for an outcome measure, we will prefer time points that are closest to 6 months.

Direct, indirect and mixed comparisons of interventions

An NMA will be performed using Stata V.16.1 (StataCorp) as described by Shim *et al*[42] for each HRQoL domain. HRQoL is usually measured with continuous outcomes. If more than one outcome (eg, visual analogue scale and Oswestry Disability Index) is presented for a study in a specific domain, the outcomes will be pooled in the study using a fixed-effects model before the NMA.

Following the GRADE[40] approach, in cases of high certainty and a ≥50% contribution of the direct estimate, the NMA estimate will be evaluated by the choice of the direct estimate, the most contributing estimate or the highest-rated estimate of the direct or indirect evidence and additionally by assessing incoherence and imprecision.[23]

To rank the interventions (as mentioned in table 1), the surface under the cumulative rank curve (SUCRA) between all interventions will be calculated (a higher

SUCRA corresponds to a better treatment effect) and Stata's network rank will be used.

The evidence network will be graphically represented using Stata's network map, a command in which direct comparisons between different interventions are shown with a network diagram (the size of the nodes represents the sample size of each intervention; the thickness of the lines connecting the nodes indicates the number of studies that directly compare the two interventions).

Assessment of inconsistency

To test whether the estimated effects from the direct comparisons matched those from the indirect comparisons, the global inconsistency will be evaluated and the local inconsistency assessed using the node-splitting method. If there is no evidence ($p<0.05$) for inconsistency, the consistency model will be used; otherwise, the inconsistency model will be used.

Network heterogeneity across all treatment contrasts will be tested using the I^2 statistic and loop-specific heterogeneity using the tau^2 statistic.

Subgroup analysis and sensitivity analysis

We will present different subgroup analyses (RCT-only, high-quality studies) and stratified analyses (time points). For the sake of a comprehensive approach, we plan to include all existing evidence from controlled trials. However, as recommended by Bröckelmann *et al*,[43] the final decision on whether to include a non-RCT in the NMA will take into account similarity regarding patient population, interventions, outcome, risk of bias, coherence of effect estimates as well as the trustworthiness of the evidence and the result of the authors' discussion.[26]

Publication bias

To check for publication bias, a network funnel plot (Stata's netfunnel command) will be created, and publication bias will be visually assessed using the criterion of symmetry.

Patient and public involvement

None.

ETHICS AND DISSEMINATION

Ethical approval is not required. The research will be published in a peer-reviewed journal.

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41 Chinn S. A simple method for converting an odds ratio to effect size for use in meta-analysis. *Statist Med* 2000;19:3127–31.
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Supplemental Material 1. Search strategies

Ovid MEDLINE (R) All search expression

#	Searches	
1	fractures, bone/ or spinal fractures/	84136
2	lumbar vertebrae/ or thoracic vertebrae/ 71100	71100
3	((burst or lumba* or thorac* or vertebra* or spin*) adj5 fracture*).ti,ab,kw.	26955
4	1 and 2	7344
5	3 or 4	28942
6	conservative treatment/ or minimally invasive surgical procedures/ or spinal fusion/ or fracture fixation/ or fracture fixation, internal/	116165
7	((spin* adj4 fusion*) or spondylodes* or minimal* invasive surg* or minimal* surgical procedure* or (short segment adj4 fixation*) or (short segment adj4 fusion*) or (long segment adj4 fixation*) or (long segment adj4 fusion*) or (operative adj4 therap*) or (operative adj4 treatment*) or surg* or instrument* or (fracture* adj4 fixation*) or stabilization or (conservative* adj4 therap*) or (conservative* adj4 treatment*) or (non-surg* adj4 treatment*) or (non-surg* adj4 therap*) or (nonsurg* adj4 therap*) or (nonsurg* adj4 treatment*) or (nonoperative* adj4 treatment*) or (nonoperative* adj4 therap*) or (conservative* adj4 technique*) or (non-surg* adj4 technique*) or (nonsurg* adj4 technique*) or (nonoperative* adj4 technique*) or (non-operative* adj4 technique*)).ti,ab,kw.	2607602
8	6 or 7	2647648
9	health status/ or "quality of life"/ or "Value of Life"/	318862
10	(quality of life or life quality or quality adjusted life or well being or health status or mental health or daily living or general health or physical function).ti,kw,ab.	697890
11	(sf36 or sf 36 or short form 36 or shortform 36 or short form36 or shortform36 or sf thirtysix or sfthirtysix or sfthirty six or sf thirty six or shortform thirtysix or shortform thirty six or short form thirtysix or short form thirty six).mp.	29127
12	(low back outcome scale or VAS or visual analog scale or oswestry disability index or ODI or RMDQ or Roland-Morris Disability Questionnaire or denis work scale or denis pain scale).mp.	83715
13	((instrument or instruments) adj3 quality of life).ab.	3760
14	(hql or hqol or h qol or hrqol or hr qol).ti,ab,kf.	21882
15	(quality of wellbeing or quality of well being or index of wellbeing or index of well being or qwb).ti,ab,kf.	671
16	(health adj3 (utilit* or status)).ti,ab,kf.	85412
17	or/9-16	882640
18	randomized controlled trial.pt.	572654
19	controlled clinical trial.pt.	94945
20	randomized.ab.	568163
21	placebo.ab.	229937
22	randomly.ab.	386697
23	trial.ab.	607906
24	groups.ab.	2378202
25	18 or 19 or 20 or 21 or 22 or 23 or 24	3417941
26	exp animals/ not humans.sh.	5026051
27	25 not 26	2930231
28	exp Cohort Studies/	2370387
29	cohort$.tw.	766437

30	controlled clinical trial.pt.	94945
31	exp Epidemiologic Methods/	7116663
32	limit 31 to yr=1966-1989	521508
33	exp Case-Control Studies/	1336324
34	(case$ and control$).tw.	569602
35	or/28-30,32-34	3687209
36	27 or 35	5713854
37	5 and 8 and 17 and 36	1327

Embase PICO search expression

('thoracolumbar fracture'/exp OR 'thoraco-lumbar fracture' OR 'thoracolumbar fracture' OR 'thoracolumbar spinal fracture' OR 'thoracolumbar spine fracture' OR 'lumbar spine fracture'/exp OR 'fractured lumbar spine' OR 'fractured lumbar vertebra' OR 'fractured lumbar vertebrae' OR 'lumbar fracture' OR 'lumbar spinal fracture' OR 'lumbar spine fracture' OR 'lumbar vertebra fracture' OR 'lumbar vertebrae fracture' OR 'lumbar vertebral fracture' OR 'thoracal fracture' OR 'burst fracture'/exp OR 'burst fracture' OR 'burst spinal fracture' OR 'burst spine fracture' OR 'burst type fracture' OR 'burst type spinal fracture' OR 'burst vertebral fracture' OR 'vertebral burst fracture')
AND
('spine fusion'/exp OR 'dorsal spine fusion' OR 'fusion, spine' OR 'spinal fusion' OR 'spine fusion' OR 'spine interbody fusion' OR 'spondylosyndesis' OR 'vertebral condensation' OR 'vertebral fusion' OR 'spondylodesis'/exp OR 'intervertebral spondylodesis' OR 'spondylodesis' OR 'conservative treatment'/exp OR 'conservative management' OR 'conservative therapy' OR 'conservative treatment' OR 'nonoperative treatment' OR 'nonsurgical treatment' OR 'organ sparing treatment' OR 'organ sparing treatments' OR 'treatment, conservative' OR 'minimally invasive procedure'/exp OR 'mini-invasive method' OR 'mini-invasive methods' OR 'mini-invasive procedure' OR 'mini-invasive procedures' OR 'mini-invasive technique' OR 'mini-invasive techniques' OR 'mini-invasive therapy' OR 'mini-invasive treatment' OR 'minimally invasive method' OR 'minimally invasive methods' OR 'minimally invasive procedure' OR 'minimally invasive procedures' OR 'minimally invasive technique' OR 'minimally invasive techniques' OR 'minimally invasive therapy' OR 'minimally invasive treatment' OR 'fracture fixation'/exp OR 'bone fixation' OR 'bone fracture fixation' OR 'fixation, bone' OR 'fracture fixation' OR 'short segment fixation'/exp OR 'surgery'/exp OR 'diagnosis, surgical' OR 'diagnostic techniques, surgical' OR 'operation' OR 'operation care' OR 'operative intervention' OR 'operative repair' OR 'operative restoration' OR 'operative surgery' OR 'operative surgical procedure' OR 'operative surgical procedures' OR 'operative treatment' OR 'resection' OR 'specialties, surgical' OR 'surgery' OR 'surgery, operative' OR 'surgical care' OR 'surgical correction' OR 'surgical diagnosis' OR 'surgical diagnostic techniques' OR 'surgical exposure' OR 'surgical intervention' OR 'surgical management' OR 'surgical operation' OR 'surgical practice' OR 'surgical procedures, operative' OR 'surgical repair' OR 'surgical research' OR 'surgical restoration' OR 'surgical service' OR 'surgical speciality' OR 'surgical specialties' OR 'surgical specialty' OR 'surgical therapy' OR 'surgical treatment')
AND
('health status'/exp OR 'clinical state' OR 'health state' OR 'health status' OR 'quality of life'/exp OR 'hrql' OR 'health related quality of life' OR 'life quality' OR 'quality of life' OR 'short form 36'/exp OR '36 item short form health survey' OR 'sf-36' OR 'sf36' OR 'short form 36' OR 'short form 36 health survey' OR 'low back outcome score'/exp OR 'visual analog scale'/exp OR 'visual analog scale' OR 'visual analog scaling' OR 'visual analogue scale' OR 'oswestry disability index'/exp OR 'odi (oswestry disability index)' OR 'oswestry disability index' OR 'oswestry disability questionnaire' OR 'oswestry index' OR 'oswestry questionnaire' OR 'oswestry low back pain disability index' OR 'oswestry low back pain disability questionnaire' OR 'oswestry scale' OR 'oswestry score' OR 'oswestry scores' OR

'roland morris disability questionnaire'/exp OR 'roland morris disability scale' OR 'roland morris disability questionnaire' OR 'roland morris disability score')
AND
('randomized controlled trial'/exp OR 'controlled trial, randomized' OR 'randomised controlled study' OR 'randomised controlled trial' OR 'randomized controlled study' OR 'randomized controlled trial' OR 'trial, randomized controlled' OR 'controlled clinical trial'/exp OR 'clinical trial, controlled' OR 'controlled clinical comparison' OR 'controlled clinical drug trial' OR 'controlled clinical experiment' OR 'controlled clinical study' OR 'controlled clinical test' OR 'controlled clinical trial' OR 'controlled study'/exp OR 'control group study' OR 'control group trial' OR 'controlled study' OR 'controlled trial' OR 'case control study'/exp OR 'case control study' OR 'case-control studies' OR 'case-control study' OR 'control study, case' OR 'matched case control' OR 'matched case control studies' OR 'matched case control study')
AND
[2000-2023]/py
Results: 261

Google Scholar search expression

Advanced search	
With all the words	fractures
With the exact phrase	randomized controlled trial
With at least one of the words	thoracolumbar spine
Without the words	
Where my words occur	anywhere in the article
Return articles authored by	
Return articles dated between	2000-2023
Sort by relevance	
We looked at result NR 1 to NR 200	

Scopus search expression

(TITLE-
ABS (((burst OR lumba* OR thorac* OR vertebra* OR spin*) W/4 fracture*)))
AND
(TITLE-ABS (((spin* W/ 4 fusion*) OR spondylodes* OR "minimal* invasive surg*" OR "minimal* surgical procedure*" OR ("short segment" W/ 4 fixation*) OR ("short segment" W/ 4 fusion*) OR ("long segment" W/ 4 fixation*) OR ("long segment" W/ 4 fusion*) OR (operative W/ 4 therap*) OR (operative W/ 4 treatment*) OR surg* OR instrument* OR (fracture* W/ 4 fixation*) OR stabilization OR (conservative* W/ 4 therap*) OR (conservative* W/ 4 treatment*) OR (non-surg* W/ 4 treatment*) OR (non-surg* W/ 4 therap*) OR (nonsurg* W/ 4 therap*) OR (nonsurg* W/ 4 treatment*) OR (nonoperative* W/ 4 treatment*) OR (nonoperative* W/ 4 therap*) OR (conservative* W/4 technique*) OR (non-surg* W/ 4 technique*) OR (nonsurg* W/ 4 technique*) OR (nonoperative* W/ 4 technique*) OR (non-operative* W/ 4 technique*))))
AND
(TITLE-ABS (("quality of life" OR "life quality" OR "quality adjusted life" OR "well being" OR "health status" OR "mental health" OR "daily living" OR "general health" OR "physical function" OR sf36 OR sf32 OR "short form 36" OR "shortform 36" OR "short form36" OR "sfthirtysix" OR "sfthirty six" OR "sf thirty six" OR "shortform thirtysix" OR "shortform thirty six" OR "short form thirtysix" OR "short form thirty six" OR "low back outcome scale" OR "low back outcome scale" OR vas OR "visual analog scale" OR "oswestry disability index" OR odi OR rmdq OR "roland-morris disability questionnaire" OR "denis work scale" OR "denis pain scale" OR (instruments W/ 4 "quality of life") OR hql OR hrqol OR "hqol" OR hrqol OR "hr qol" OR "quality of wellbeing" OR "quality of well being" OR "index of wellbeing" OR "index of well being" OR "qwb" OR "health utilit* status")))
AND
(TITLE-ABS (("randomized controlled trials" OR "quasi-randomized controlled trials" OR "quasi randomized controlled trials" OR "non-randomized controlled trials" OR "non randomized controlled trials" OR "controlled cohort studies" OR "controlled trials" OR "controlled studies" OR "case control studies" OR "case-control studies")))

Refined By:
Publication Years: 2000-2023
Web of Science Index: Emerging Sources Citation Index (ESCI) or Science Citation Index Expanded (SCI-EXPANDED)
Results: 134

Web of Science search expression

1 TI=((burst OR lumba* OR thorac* OR vertebra* OR spin*) NEAR/4 fractur*)

2 TI=((spin* NEAR/4 fusion*) OR spondylodes* OR "minimal* invasive surg*" OR "minimal* surgical procedure*" OR ("short segment" NEAR/4 fixation*) OR ("short segment" NEAR/4 fusion*) OR ("long segment" NEAR/4 fixation*) OR ("long segment" NEAR/4 fusion*) OR (operative NEAR/4 therap*) OR (operative NEAR/4 treatment*) OR surg* OR instrument* OR (fracture* NEAR/4 fixation*) OR stabilization OR (conservative* NEAR/4 therap*) OR (conservative* NEAR/4 treatment*) OR (non-surg* NEAR/4 treatment*) OR (non-surg* NEAR/4 therap*) OR (nonsurg* NEAR/4 therap*) OR (nonsurg* NEAR/4 treatment*) OR (nonoperative* NEAR/4 treatment*) OR (nonoperative* NEAR/4 technique*) OR (non-surg* NEAR/4 technique*) OR (nonsurg* NEAR/4 technique*) OR (nonoperative* NEAR/4 technique*) OR (non-operative* NEAR/4 technique*))

3 TI=(("quality of life" OR "life quality" OR "quality adjusted life" OR "well being" OR "health status" OR "mental health" OR (daily NEAR/1 living) OR (general NEAR/1 health) OR (physical NEAR/1 function) OR sf36 OR "sf 36" OR "short form 36" OR "shortform 36" OR "short form36" OR shortform36 OR "sf thirtysix" OR sfthirtysix OR "sfthirty six" OR "sf thirty six" OR "shortform thirtysix" OR "shortform thirty six" OR "short form thirtysix" OR "short form thirty six" OR "low back outcome scale" OR VAS OR "visual analog scale" OR "oswestry disability index" OR ODI OR RMDQ OR "Roland-Moris Disability Questionnaire" OR "denis work scale" OR "denis pain scale" OR hql OR hqol OR "h qol" OR hrqol OR "hr qol" OR "quality of wellbeing" OR "quality of well being" OR "index of wellbeing" OR "index of well being" OR qwb OR (health NEAR/4 (utilit* OR status)) OR (instrument NEAR/4 "quality of life")))

4 TI=((random* OR control* OR study OR trial OR compar* OR group OR groups OR therapy OR treatment OR intervention))

5 AB=((burst OR lumba* OR thorac* OR vertebra* OR spin*) NEAR/4 fractur*)

6 AB=((spin* NEAR/4 fusion*) OR spondylodes* OR "minimal* invasive surg*" OR "minimal* surgical procedure*" OR ("short segment" NEAR/4 fixation*) OR ("short segment" NEAR/4 fusion*) OR ("long segment" NEAR/4 fixation*) OR ("long segment" NEAR/4 fusion*) OR (operative NEAR/4 therap*) OR (operative NEAR/4 treatment*) OR surg* OR instrument* OR (fracture* NEAR/4 fixation*) OR stabilization OR (conservative* NEAR/4 therap*) OR (conservative* NEAR/4 treatment*) OR (non-surg* NEAR/4 treatment*) OR (non-surg* NEAR/4 therap*) OR (nonsurg* NEAR/4 therap*) OR (nonsurg* NEAR/4 treatment*) OR (nonoperative* NEAR/4 treatment*) OR (nonoperative* NEAR/4 technique*) OR (non-surg* NEAR/4 technique*) OR (nonsurg* NEAR/4 technique*) OR (nonoperative* NEAR/4 technique*) OR (non-operative* NEAR/4 technique*))

7 AB=(("quality of life" OR "life quality" OR "quality adjusted life" OR "well being" OR "health status" OR "mental health" OR (daily NEAR/1 living) OR (general NEAR/1 health) OR (physical NEAR/1 function) OR sf36 OR "sf 36" OR "short form 36" OR "shortform 36" OR "short form36" OR shortform36 OR "sf thirtysix" OR sfthirtysix OR "sfthirty six" OR "sf thirty six" OR "shortform thirtysix" OR "shortform thirty six" OR "short form thirtysix" OR "short form thirty six" OR "low back outcome scale" OR VAS OR "visual analog scale" OR "oswestry disability index" OR ODI OR RMDQ OR "Roland-Moris Disability Questionnaire" OR "denis work scale" OR "denis pain scale" OR hql OR hqol OR "h qol" OR hrqol OR "hr qol" OR "quality of wellbeing" OR "quality of well being" OR "index of wellbeing" OR "index of well being" OR qwb OR (health NEAR/4 (utilit* OR status)) OR (instrument NEAR/4 "quality of life")))

8 AB=((random* OR control* OR study OR trial OR compar* OR group OR groups OR therapy OR treatment OR intervention))

9 #8 AND #7 AND #6 AND #5 AND #4 AND #3 AND #2 AND #1

Results: 823

Supplemental Material 2. Treatment groups

Less detailed: 4 groups
1 “isolated short post (MIS and open)”
2 “short post with ant fusion”
3 “isolated long post (MIS and open)”
4 “cons”

More detailed: 14 Groups
0 "short post ant fusion"
1 "isolated very short post"
2 "MIS short post"
3 "MIS short post intermed screw"
4 "open short post"
5 "open short post intermed screw"
6 "short post kypho vertebro"
7 "isolated short ant"
8 "long post open"
9 "long post MIS"
10 "long post kypho vertebra cement"
11 "cons orthosis"
12 "cons no orthosis"
13 "other"

Abbreviation:
MIS: minimally invasive surgery
Open: Open surgery
Ant: anterior
Post: posterior
Cons: conservative treatment
Intermed: intermediate