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REVIEW ARTICLE

The efficacy of postoperative bracing after spine surgery for lumbar degenerative diseases: a systematic review

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Abstract

Purpose Postoperative bracing treatment is widely used after surgery for lumbar degenerative diseases. However, the guidelines are lacking in this regard, and its use is mainly driven by individual surgeon preferences. The objective of the current review was to evaluate the available evidence on the use of postoperative bracing after surgery for degenerative disease of the lumbar spine.

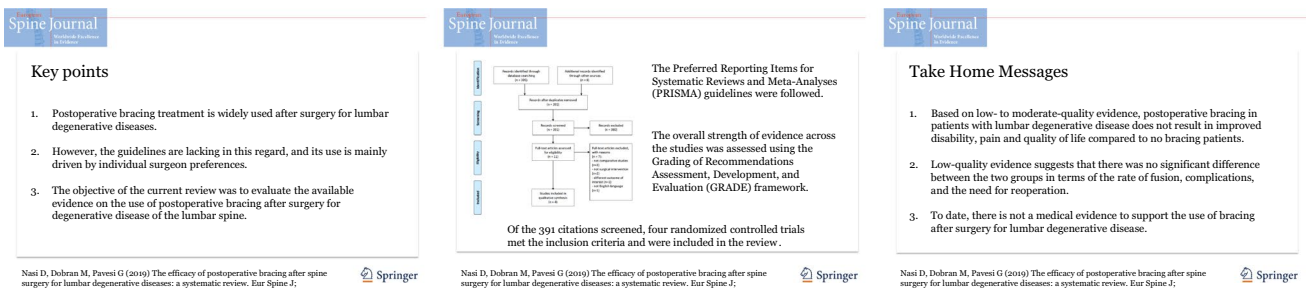
Methods The Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were followed while conducting a systematic search of the PubMed/Medline, Scopus, and Cochrane databases from January 1990 to January 2019. High-quality studies were included that evaluated disability, pain, quality of life, the rate of fusion, complications, and rate of reoperations in patients who had surgery for lumbar degenerative disease, with and without postoperative bracing. The overall strength of evidence across the studies was assessed using the Grading of Recommendations Assessment, Development, and Evaluation framework.

Results Of the 391 citations screened, four randomized controlled trials met the inclusion criteria and were included in the review. Based on low- to moderate-quality evidence, postoperative bracing in patients with lumbar degenerative disease does not result in improved disability, pain, and quality of life compared to no bracing patients. Low-quality evidence suggests that there was no significant difference between the two groups in terms of the rate of fusion, complications, and the need for reoperation.

Conclusions To date, there is not a medical evidence to support the use of bracing after surgery for lumbar degenerative disease.

Graphic abstract

These slides can be retrieved under Electronic Supplementary Material.



Keywords Postoperative bracing · Spine surgery for lumbar degenerative disease · Lumbar spinal fusion · Lumbar microdiscectomy · Lumbar spine surgery

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Extended author information available on the last page of the article

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Introduction

The use of bracing following various types of surgery for lumbar degenerative disease is common, and it extends to fusion procedures, as well as microdiscectomy and laminectomy [1–4]. Postoperative bracing was, respectively, prescribed for 49% and 38% of the patients in two survey-based studies in North America and Europe following lumbar procedures [5, 6].

The theoretical advantages of bracing include a reduction in intervertebral motion and biomechanical loading on the area of the spine undergoing surgery, with a subsequent supposed improvement in functional outcomes and rate of fusion (e.g. in posterior or interbody fusion procedures), and a reduction in pain [7–12].

On the contrary, back muscle atrophy secondary to prolonged external immobilization, skin irritation, high costs for patients and society, rehabilitative delays, and discomfort are disadvantages associated with the use of bracing treatment [7–12].

Accordingly, consensus remains lacking on the necessity of postoperative bracing after surgery for lumbar degenerative disc disease, and the debate on this continues. Neurosurgeons frequently prescribe postoperative bracing based on their experience and training rather than on current evidence in the literature [5, 6].

Thus, the objective of this review was to evaluate the available evidence on the use of postoperative bracing in patients after surgery for lumbar degenerative diseases.

The results of high-quality studies that compared the effects of postoperative bracing treatment versus the lack of bracing treatment after surgery on disability, pain, quality of life, rate of fusion, complications, and the need of reoperations were synthesized in this review.

Finally, the overall strength of evidence across the studies was assessed using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework.

Materials and methods

Eligibility criteria

Studies were included if they compared levels of disability, pain, quality of life, the rate of fusion and complications, and the need for reoperation in patients treated with postoperative bracing, versus those in patients who did not receive postoperative bracing treatment, after surgery for lumbar degenerative disease.

Abstracts and titles were independently reviewed and classified according to the inclusion criteria by two authors (DN and MD). Case–control studies, cohort studies, and clinical trials were included. Non-comparative case series, case reports, technical notes, letters, and editorials were excluded.

Information sources and search strategy

A systematic review of the literature was performed of articles in which a comparative evaluation was made between the levels of disability, pain, quality of life, rate of fusion, and complications in patients who received postoperative bracing after surgery for lumbar degenerative disease and these levels in a similar set of patients who did not receive bracing, using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

The titles of articles in the PubMed/Medline, Scopus, and Cochrane databases were searched, using the keywords "bracing AND lumbar spinal surgery" and "orthotic devices AND lumbar spinal surgery." The search was restricted to original clinical research published between January 1990 and January 2019, after which the reference lists of the relevant articles and published reviews were screened.

Data items

The four main research questions (Qs) for the current review were:

- Q1: Does the use of brace after surgery for lumbar spinal degenerative disease improved disability, pain, and quality of life compared to no bracing patients?
- Q2: Does the use of brace after instrumented fusion for lumbar spinal degenerative disease improved rates of fusion compared to no bracing patients?
- Q3 Does the use of brace after surgery for lumbar spinal degenerative disease reduced rates of complication compared to no bracing patients?
- Q4: Does the use of brace after surgery for lumbar spinal degenerative disease reduced rates of reoperation compared to no bracing patients?

Risk of bias in individual studies

The quality and risk of bias of the individual studies were determined using Levels of Evidence for Primary Research Question, the evidence-based guideline development methodology of the North American Spine Society (NASS) [13]. The levels of evidence range included:

- Level I: high-quality randomized controlled trial and systematic review of level I RCTs (and study results were homogenous);
- Level II: lesser quality RCTs (e.g. ≤80% follow-up, no blinding, or improper randomization), prospective comparative studies, systematic review of level II studies or level I studies with inconsistent results;
- Level III: case–control study, retrospective comparative study, and systematic review of level III studies;
- Level IV: case series;

Synthesis of results and strength of evidence across the studies

The evidence for each question was evaluated using the Grading of Recommendation Assessment, Development, and Evaluation (GRADE) scoring system [14]. The strength of evidence for each of the research questions was classified as:

1. High, if half or more of the studies were high-quality RCTs.
2. Moderate, if half or more than half of the studies were lesser quality RCTs or prospective comparative studies,
3. Low, if half or more than half of the studies were observational studies, case–control studies, or retrospective comparative studies.

The level of evidence was downgraded (i.e. from moderate to low) if there was a risk of bias, the results were inconsistent, there was indirect evidence, the estimates of the effects were imprecise (e.g. wide confidence intervals), or there was publication bias. Similarly, the level of evidence was upgraded (i.e. from level low to moderate) if the studies had a large magnitude of effect, even if they constituted retrospective research.

Results

Study selection and characteristics

Of the 391 citations screened, four randomized controlled trials met the inclusion criteria and were included in this review [1–4] (Fig. 1). The particulars of the individual

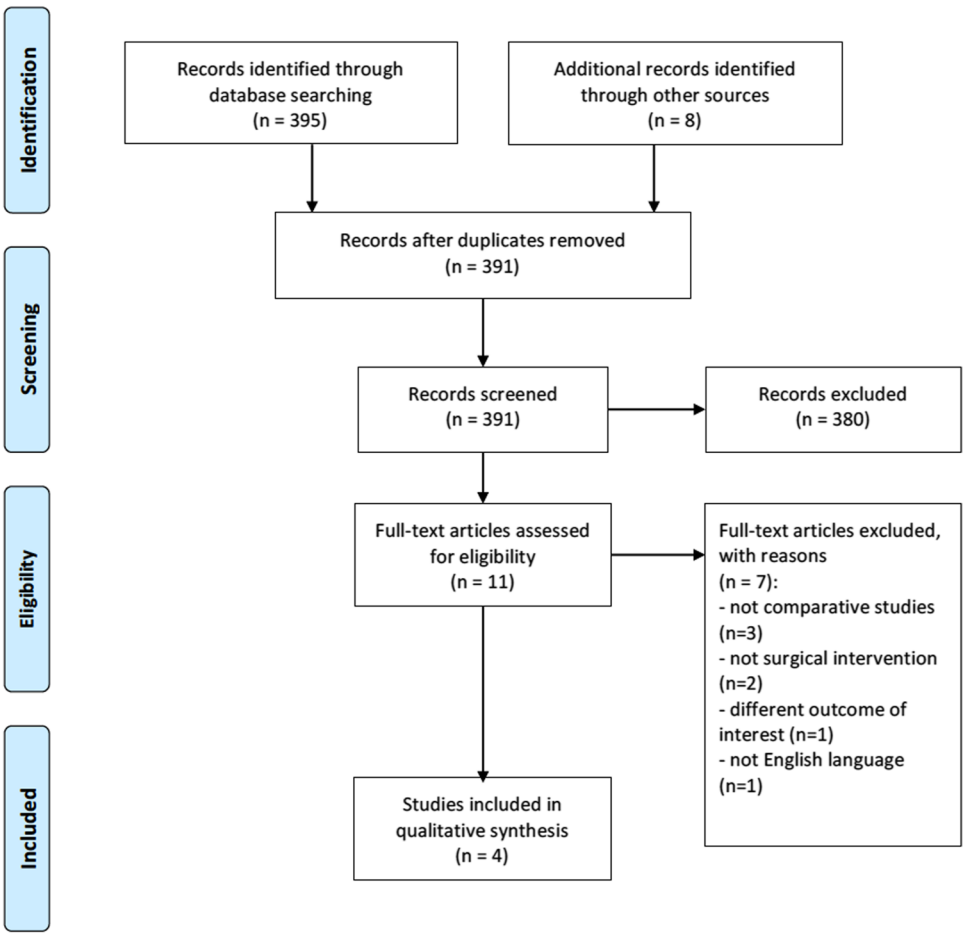

Fig. 1 Flowchart of search mechanism according to PRISMA guidelines

studies, such as the study design, patient sample, characteristics, diagnosis, type of surgery, use of postoperative bracing, outcome assessment tools, follow-up, dropout rates, and outcomes, are detailed in Table 1.

The quality and strength of the scientific evidence provided in each study were graded using modified NASS criteria [13]. All four of the included RCTs were downgraded from level I to level II. An evaluation of the risk of bias and the reasons why the studies were downgraded are provided in Table 2.

Finally, the overall body of evidence for each question, determined using the GRADE scoring system, was summarized (Table 3). The overall strength of the evidence ranged from "low" to "moderate."

Type and timing of postoperative brace

In two studies [2, 3] the lumbar corset used was rigid (Soliman et al. reported the use of a "rigid molded lumbosacral orthosis," while Yao et al. reported the use of a "rigid lumbosacral brace [Knight–Taylor (chairback) brace]) and was prescribed, respectively, for full time for 8 weeks followed by daytime wear for another 4 weeks and for full time for 12 weeks. On the contrary, in the study of Yee et al. [1] patients have worn a lumbar corset of canvas material with two posterior metallic supports for full time for 8 weeks after posterolateral posterior fusion. Finally, Zoia et al. [4] reported the use of a semirigid lumbar corset (i.e. with posterior flexible stays and abdominal straps) for 4 weeks during upright position.

Results of individual studies and synthesis of results

Q1 Does the use of brace after surgery for lumbar spinal degenerative disease improved disability, pain, and quality of life compared to no bracing patients?

Three studies [2–4] compared disability by assigning an Oswestry Disability Index (ODI) score to patients who received postoperative bracing and those who did not after surgery for lumbar degenerative disease. Of these, Soliman et al. [2] and Yao et al. [3] assessed the utility of bracing following posterior instrumented fusion and open TLIF, respectively, while Zoia et al. [4] evaluated the efficacy of bracing treatment after single-level microdiscectomy.

Soliman et al. [2] reported that the improvement in ODI at three months after surgery was significantly greater in the control group ($p=0.010$), compared to the bracing treatment group. By contrast, a significant difference in ODI between the two groups was not reported at the follow-up in the studies by Yao et al. and Zoia et al. [3, 4].

Elsewhere, a difference in disability levels between the bracing treatment and control group was not found using the Dallas Pain Questionnaire (DPQ) after posterior fusion [1].

Visual Analogue Scale (VAS) scores were also assigned to the two groups in these three studies at three, six, and 12 months after surgery [2–4]. A significant difference between the groups was not reported at the 6- and 12-month follow-up by Yao et al. [3] and Zoia et al. [4]. Conversely, Soliman et al. [2] reported a significantly higher improvement in the VAS score at three months after surgery in the control group ($p=0.010$), compared to the bracing treatment group.

Differences in quality of life, determined using various subscales of the 36-Item Short-Form Survey (SF-36), were not found between the postoperative SF-36 domain and component scores for patients who received bracing treatment and the control (those who did not have bracing treatment) after posterior fusion ($p=0.380$ for PF, $p=0.280$ for BP, $p=0.230$ for GH, $p=0.410$ for RP, $p=0.250$ for VT, $p=0.790$ for SF, $p=0.860$ for RE, $p=0.300$ for MH, $p=0.300$ for PCS, and $p=0.570$ for MCS) [1].

In summary, based on the moderate-quality evidence that is available, postoperative bracing after surgery (including various types of fusion and simple microdiscectomy) in patients with lumbar degenerative disease did not lead to an improvement in the ODI and VAS scores. Similarly, according to the low-quality evidence that is available, an improvement was not seen in the DPQ, the Roland Morris Disability Questionnaire (RMDQ), and SF-36 (and subscales) scores following postoperative bracing in patients with lumbar degenerative disease.

Q2 Does the use of brace after instrumented fusion for lumbar spinal degenerative disease improved rates of fusion compared to no bracing patients?

Two studies compared the rate of fusion in patients with degenerative spine conditions who received and who did not receive postoperative bracing treatment after treatment with instrumented posterior arthrodesis [1, 3]. Yee et al. [1] performed a radiologic evaluation of rates of fusion at 12 months and 24 months after posterior lumbar arthrodesis with an autologous iliac crest bone graft and with pedicle screw instrumentation. A difference between the bracing treatment and control groups was not reported.

In the study by Yao et al. [3], fusion after TLIF was assessed by CT at the six- and 12-month postoperative follow-up using the Brantigan, Steffee, Fraser classification. The average rate of fusion was 80% in the bracing treatment group and 85% in the non-bracing treatment group ($p=0.516$) at the 12-month postoperative follow-up.

In summary, based on the low-quality evidence that is available, postoperative bracing in patients with degenerative lumbar disease did not lead to an improvement

Table 1 Characteristics and results of included studies

Author, journal, year	Type of study	Total no of pts	Brace group (*n*)	Control group (*n*)	Brace group mean age (range)	Control group mean age (range)	Bracing group diagnosis	Control group diagnosis	Type of surgical treatment	Type of bracing	Time of bracing	Follow-up	Drop-out *n*	Postoperative differences (results of RCT) for primary outcome	Postoperative differences (results of RCT) for secondary outcomes
Yee et al., J Bone Joint Surg Am, 2008 [1]	RCT	90	46	44	52 (NR)	53 (NR)	Stenosis = 11 Degenerative spondylolisthesis = 13 Isthmic spondylolisthesis = 8 Junctional syndrome = 1 Pseudarthrosis = 2 Iatrogenic/post-op instability = 2	Stenosis = 12 Degenerative Spondylolisthesis = 12 Isthmic Spondylolisthesis = 5 Junctional Syndrome=2 Pseudarthrosis = 2 Iatrogenic/post-op instability = 1 Congenital Stenosis = 1	Posterior lumbar arthrodesis (autologous iliac crest bone graft and pedicle screw instrumentation)	Lumbar corset used consisted of canvas material with two posterior metallic supports	Full time for 8 weeks	12 and 24 months after surgery	18	There were no differences between the brace group and the control group with respect to: postoperative DPQ category scores ($p = 0.34$ for the daily activity category, $p = 0.67$ for the work/leisure category, $p = 0.17$ for the anxiety–depression category and $p = 0.40$ for the social category)	There were no differences between the brace group and the control group with respect to: 1) postoperative SF-36 domain and component scores ($p = 0.38$ for PF, $p = 0.28$ for BP, $p = 0.23$ for GH, $p = 0.41$ for RP, $p = 0.25$ for VT, $p = 0.79$ for SF, $p = 0.86$ for RE, $p = 0.30$ for MH, $p = 0.30$ for PCS and $p = 0.57$ for MCS) 2) the distribution of surgical complications or subsequent revision rates ($p = 0.8$) 3) rates of fusion seen radiographically at 12 months ($p = 0.8$) or 24 months ($p = 0.9$) postoperatively 4) Rates of revision surgery due to symptomatic non-union ($p = 0.43$)

Table 1 (continued)

Author, journal, year	Type of study	Total no of pts	Brace group (*n*)	Control group (*n*)	Brace group mean age (range)	Control group mean age (range)	Bracing group diagnosis	Control group diagnosis	Type of surgical treatment	Type of bracing	Time of bracing	Follow-up	Drop-out *n*	Postoperative differences (results of RCT) for primary outcome	Postoperative differences (results of RCT) for secondary outcomes
Soliman et al., Spine, 2018 [2]	RCT	43	25	18	49.4 (42.7–56.2)	54.1 (45.5–62.5)	Stenosis = 11 Degenerative disc disease = 7 Degenerative spondylolisthesis = 5 Recurrent disc herniation = 2	Stenosis = 9 Degenerative disc disease = 4 Degenerative spondylolisthesis = 5 Recurrent disc herniation = 0	Posterior lumbar instrumented fusion	Rigid molded lumbosacral orthosis	Full time for 8 weeks followed by daytime wear for another 4 weeks	6 weeks and 3 months after surgery	0	The improvement in ODI 6 weeks after surgery was not significant for both groups, and this improvement was similar between both groups ($p = 0.1$). The improvement in ODI 3 months after surgery was significant for both groups and significantly greater for the control group ($p = 0.01$)	The improvement in MCS and PCS 6 weeks after surgery was not significant for both groups; this improvement was similar between both groups ($p = 0.1$). The improvement in MCS and PCS 3 months after surgery was significant only for the control group ($p = 0.01$). The improvement in VAS 6 weeks after surgery was significant for both groups, this improvement was similar between both groups ($p = 0.1$). The improvement in VAS 3 months after surgery was greater for the control group ($p = 0.01$)

Table 1 (continued)

Author, journal, year	Type of study	Total no of pts	Brace group (*n*)	Control group (*n*)	Brace group mean age (range)	Control group mean age (range)	Bracing group diagnosis	Control group diagnosis	Type of surgical treatment	Type of bracing	Time of bracing	Follow-up	Drop-out *n*	Postoperative differences (results of RCT) for primary outcome	Postoperative differences (results of RCT) for secondary outcomes
Yao et al., Clin Spine Surg, 2018 [3]	RCT	90	44	46	69.16 (NR)	68.78 (NR)	Degenerative disc disease = *n* NR Degenerative spondylolisthesis = *n* NR Spondylolytic spondylolisthesis = *n* NR	Degenerative disc disease = *n* NR Degenerative spondylolisthesis = *n* NR Spondylolytic spondylolisthesis = *n* NR	Open TLIF	Rigid lumbosacral brace [Knight–Taylor (chair-back) brace]	Full time for 12 weeks✻	6 weeks, 3, 6, and 12 months after surgery	49	1) There was no significant delta change in the VAS and ODI score 12 months postoperatively between the two groups. 2) The fusion rates were 79.5% in the brace group and 84.8% in the no brace group ($p = 0.516$) at the 12-month postoperative follow-up. 3) The total complication rates were 15.2% in the no brace group and 11.4% in the brace group ($p = 0.591$). 4) The reoperation rate in both groups was 0%	
Zoia et al., JNSpine, 2018 [4]	RCT	54	29	25	44.7 (NR)	45.6 (NR)	Single-level lumbar disc herniation (without signs of instability)	Single-level lumbar disc herniation (without signs of instability)	Single-level lumbar microdiscectomy with an interlaminar paramedian approach	Semirigid lumbar corset (i.e. with posterior flexible stays and abdominal straps)	4 weeks during upright position	1 and 6 months after surgery	0	No significant differences between the two groups were reported at either postoperative time point for any given outcome irrespective of any scale employed (not reported *p* value)	

Table 2 Quality and risk of bias of each individual study included in this review according to the modified NASS criteria

Author, Journal, Year	Type of Study	Level of Evidence	Risk of Bias
Yee et al., J Bone Joint Surg Am, 2008 [1]	RCT	II	The study was downgraded from Class I to Class II because: 1) of 90 randomized, only 72 were included in their analysis, and therefore the study did not use intention-to-treat analysis; 2) failure to provide a power calculation for an RCT (no statistically significant difference on DPQ and SF-36 between the two groups at 24-month follow-up with wide confidence intervals)
Soliman et al., Spine, 2018 [2]	RCT	II	The study was downgraded from Class I to Class II because: 1) small sample size (43 patients); 2) co-interventions variability (15/25 patients in brace group received TLIF in addition to posterior fusion compared to 11/18 in control group); 3) short follow-up (3 months); 4) failure to provide a power calculation for an RCT
Yao et al., Clin Spine Surg, 2018 [3]	RCT	II	The study was downgraded from Class I to Class II because: 1) > 35% of patients were lost at follow-up 2) The outcome assessment was not blinded 3) The compliance with wearing the lumbar corset varied in the brace group
Zoia et al., JNSpine, 2018 [4]	RCT	II	The study was downgraded from Class I to Class II because: 1) The outcome assessment was not blinded; 2) failure to provide a power calculation for an RCT; 3) failure to provide flowchart following patients through course of RCT

in the rate of fusion after posterior or interbody instrumented fusion.

Q3 Does the use of brace after surgery for lumbar spinal degenerative disease reduced rates of complication compared to no bracing patients?

Based on the findings of two studies [1, 3], a significant difference was not identified between the bracing treatment group and the control group with respect to postoperative complications. The low-quality evidence that is available suggests that postoperative bracing in patients with lumbar degenerative disc disease did not lead to a reduction in postoperative complications.

Q4 Does the use of brace after surgery for lumbar spinal degenerative disease reduced rates of reoperation compared to no bracing patients?

Two studies [1, 3] evaluated the need for reoperation after surgery at six weeks and then again at the three-, six-, 12-, and 24-month follow-ups. There was no difference in the number of reoperations performed between the bracing treatment and control groups.

The low-quality evidence that is available indicates that postoperative bracing in patients with lumbar degenerative disc disease did not reduce the rate of reoperation.

Discussion

Despite limited evidence to support its efficacy, the use of bracing after surgery for a variety of lumbar spine conditions remains relatively common and widespread between surgeons [5, 6]. Pain relief was the main reason provided for prescribing postoperative bracing, followed by a desire to improve the rate of fusion, in a recent European survey on the use of bracing after lumbar surgery [6]. However, these assumptions were based on the personal experience, beliefs, and training of spine surgeons rather than on current evidence in the literature [6–12].

Specific guidelines on the use of bracing after lumbar surgery are not available, with the exception of those published in 2014 by the American Association of Neurological Surgeons (AANS), which do not recommend the use of bracing after instrumented posterolateral lumbar fusion [7]. However, the AANS recommendation was based on the findings of a single randomized controlled trial that was characterized by low-quality evidence according to the NASS grades of recommendation.

The efficacy of bracing after surgery for various spinal pathologies (i.e. degenerative cervical myelopathy, adolescent idiopathic scoliosis, and lumbar degenerative disc disease) has been evaluated in only one review using the GRADE approach. Nevertheless, this review, performed in 2018, included only one randomized controlled trial on lumbar degenerative disc disease [8].

The present review evaluated the available evidence on the use of bracing treatment after surgery for lumbar degenerative disease in terms of disability, pain, quality of life, and the rate of fusion and complications using the methodology proposed by the GRADE working group [14].

Summary of evidence

The impact of postoperative bracing treatment on disability, pain, and quality of life

Reducing disability and back pain are the key goals of postoperative bracing. However, the four RCTs included in this

Table 3 The overall strength of evidence for each question according to the GRADE scoring system

Outcome	No of Participants (studies)	Quality of the evidence (GRADE)	Comments and Overall Results
Q1: Does the use of brace after surgery for lumbar spinal degenerative disease improved disability, pain, and quality of life compared to no bracing patients?			
Patient or population: people with spinal lumbar degenerative disease Settings: hospital, various countries including USA, Canada, Taiwan, and Italy intervention: brace versus control group			
Oswestry Disability Index (ODI) [2–4] Follow-up: 3 months [2], 6 months [4], 12 months [3]	187 (3 [2–4])	Moderate	No significant difference between the two groups was reported at either follow-up for ODI in study [3, 4]. The improvement in ODI 3 months after surgery was significantly greater for the control group ($p=0.01$) in study [2]
Dallas Pain Questionnaire (DPQ) [1] Follow-up: 12 and 24 months	90 (1 [1])	Low	There were no differences between the brace group and the control group with respect to postoperative DPQ at either follow-up
Roland Morris Disability Questionnaire (RMDQ) [4] Follow-up: 6 months	54 (1 [4])	Low	No significant differences between the two groups were reported
Visual Analogue Scale (VAS) [2–4] Follow-up: 3 months [2], 6 months [4], 12 months [3]	187 (3 [2–4])	Moderate	No significant difference between the two groups was reported at either follow-up for VAS in study [3, 4]. The improvement in VAS 3 months after surgery was significantly greater for the control group ($p=0.01$) in study [2]
Postoperative SF-36 domain and component scores (PF, BP, GH, RP, VT, SF, RE, MH, PCS and MCS) [1] Follow-up: 12 and 24 months	90 (1 [1])	Low	There were no differences between the brace group and the control group with respect to postoperative SF-36 domain and component scores ($p=0.38$ for PF, $p=0.28$ for BP, $p=0.23$ for GH, $p=0.41$ for RP, $p=0.25$ for VT, $p=0.79$ for SF, $p=0.86$ for RE, $p=0.30$ for MH, $p=0.30$ for PCS and $p=0.57$ for MCS)
Q2: Does the use of brace after posterior or interbody fusion for lumbar spinal degenerative disease improved rates of fusion compared to no bracing patients?			
Patient or population: people with spinal lumbar degenerative disease Settings: hospital, various countries including USA, Canada, and Taiwan Intervention: brace versus control group			
Rates of fusion seen radiographically at 12 months or 24 months after posterior lumbar arthrodesis (autologous iliac crest bone graft and pedicle screw instrumentation) [1]	90 (1 [1])	Low	There were no differences between the brace group and the control group with respect to the rates of fusion seen radiographically at 12 months ($p=0.8$) or 24 months ($p=0.9$) postoperatively
Interbody fusion after TLIF evaluated by CT at the 6- and 12-month postoperative follow-up using the Brantigan–Steffee–Fraser BSF classification [3]	90 (1 [3])	Low	The fusion rates were 79.5% in the brace group and 84.8% in the no brace group ($p=0.516$) at the 12-month postoperative follow-up
Q3: Does the use of brace after surgery for lumbar spinal degenerative disease reduced rates of complication compared to no bracing patients?			
Patient or population: people with spinal lumbar degenerative disease Settings: hospital, various countries including USA, Canada, and Taiwan intervention: brace versus control group			
Every complication after surgery at 6-week [3], 3- [3], 6- [3], 12- [1, 3], and 24-month [1] follow-up	180 (1 [1, 3])	Low	There were no differences between the brace group and the control group with respect to the surgical complications
Q4: Does the use of brace after posterior or interbody fusion for lumbar spinal degenerative disease reduced rates of reoperation compared to no bracing patients?			
Patient or population: people with spinal lumbar degenerative disease Settings: hospital, various countries including USA, Canada, and Taiwan intervention: brace versus control group			
Every reoperation after surgery at 6 weeks [3], 3 [3], 6 [3], 12 [1, 3] and 24 [1] months follow-up	180 (1 [1, 3])	Low	There were no differences between the brace group and the control group with respect to the reoperation rates

review failed to find differences in disability and pain levels between the bracing treatment and control groups after lumbar surgery [1–4].

The use of postoperative bracing has been advocated by several surgeons after non-fusion surgery to prevent incipient instability and related symptoms, including low back pain and disability [4–6]. The theoretical mechanisms associated with a reduction in disability and pain after lumbar decompression surgery include a decrease in intervertebral motion, a decrease in the amount of biomechanical loading on the area of the spine undergoing surgery, and enhanced support of the musculoskeletal system [9]. However, Zoia et al. [4] reported that no differences were observed between the bracing treatment and non-bracing treatment groups after lumbar microdiscectomy, irrespective of the scale used to the evaluate the clinical outcomes (i.e. VAS, RMDQ, or ODI).

Several authors have advocated the use of postoperative bracing to limit spinal mobility and facilitate relief from pain and disability following surgery after lumbar fusion procedures [9–12]. However, differences were not found between the bracing treatment group and the control group with respect to postoperative disability and pain levels in three RCTs in which the patients were treated with lumbar instrumented fusion [1–3].

This is also growing evidence that the restriction of movement after lumbar surgery is associated with poorer postoperative outcomes in terms of pain, disability, and overall physical health [6–15]. In this regard, several authors have reported the importance of patient education and early mobilization in rehabilitation following lumbar fusion in order to prevent a vicious pain cycle [16].

The impact of postoperative bracing treatment on the rate of fusion

Immobilization of the spine and the enhancement of fusion have been cited as reasons for the use of bracing treatment after posterior fixation of the lumbar spine or posterior lumbar interbody fusion [6–13].

Johnsson et al. [9] reported that patients who received bracing treatment for 6 months following lumbar non-instrumented fusion surgery had a higher rate of fusion (8 of the 11 patients) at one year, compared to those who used a brace for only three months (2 of 11 patients). In this study, successful fusion was considered as lack of motion with roentgen stereophotogrammetric analysis (RSA) [9]. The authors interpreted this to signify that healing of a non-instrumented lumbar fusion occurs over a six-month period. However, they did not report the effect of lumbar bracing on functional outcomes.

By contrast, the studies of Yee et al. [1] and Yao et al. [3] clearly showed that postoperative bracing in patients with degenerative lumbar disease did not enhance the rate of fusion after posterior or interbody instrumented fusion.

These data could be explained by two main reasons:

- The evolution of modern spinal instrumentation has been associated with improved fusion rates over the past decades [6, 17, 18].
- More recent biomechanical studies reported that bracing does not affects segmental spinal stability (quantified by roentgen stereophotogrammetric analysis), nor loading on the internal fixation of the spine (measured using telemeterized fixators), nor radiographically assessed fusion rates at 1- and 2-year follow-up [11, 12].

The impact of postoperative bracing treatment on the rate of complications and the need for reoperation

Two RCTs did not identify differences between the bracing treatment group and the control group regarding the number of complications and the need for reoperation [1, 3]. In the series by Yao et al. [3], two perioperative complications were reported in the non-bracing treatment group; specifically, loosening of the sacral screws was identified in two patients who underwent two-level instrumented fusion (L4–L5–S1). The authors stated that the sacrum primarily consists of cancellous bone and receives a greater mechanical load than other segments. Thus, they concluded that sacral screw loosening occurs due to structural weakness, irrespective of whether or not bracing treatment is administered [3].

Finally, an important limitation of the studies included in this review consisted in the different types and timing of bracing after surgery. This issue might affect the results of this review because rigid brace provides most support to the lumbosacral spine compared with semirigid or soft brace by limiting motion, stabilizing injured structures and providing pressure to prevent progression of a deformity. However, complications regarding rigid brace treatments such as pressure injury, discomfort, and emotional distress are higher compared to soft brace [1–15].

Conclusions

In four Class II studies, the use of postoperative bracing after spine surgery for degenerative disease did not correlate with an improvement in outcome for the patients.

Based on the results of this review, the available overall body of evidence, rated using the GRADE approach, was found to be low to moderate, and it does not support the use of postoperative bracing after surgery for lumbar degenerative disease to reduce pain and disability, improve quality of life, enhance the rate of fusion, and reduce the number

of complications and the need for reoperation. Future high-quality randomized trials are warranted to verify the results of the current study.

Compliance with ethical standards

Conflict of interest The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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