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## Clinical Study

# Postoperative bracing practices after elective lumbar spine surgery: A questionnaire study of U.S. spine surgeons<sup>☆</sup>



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## ABSTRACT

**Background:** There is limited data available on the use of orthoses across varying elective spine surgeries. When previously studied in 2009, inconsistent lumbar postoperative bracing practices were reported. The present study aimed to provide a ten-year update regarding postoperative bracing practices after elective lumbar surgery among United States (U.S.) spine surgeons.

**Methods:** A questionnaire was distributed to attendees of the Lumbar Spine Research Society Annual Meeting (April 2019). The questionnaire collected demographic information, and asked surgeons to identify if they used orthoses postoperatively after ten elective lumbar surgeries. Information regarding type of brace, duration of use, and reason for bracing was also collected. Chi-square tests and one-way analysis of variance (ANOVA) were used for comparisons.

**Results:** Seventy-three of 88 U.S. attending surgeons completed the questionnaire (response rate: 83%). The majority of respondents were orthopaedic surgery-trained (78%), fellowship-trained (84%), and academic surgeons (73%). The majority of respondents (60%) did not use orthoses after any lumbar surgery. Among the surgeons who braced, the overall bracing frequency was 26%. This rate was significantly lower than that reported in the literature ten years earlier ( $p < 0.0001$ ). Respondents tended to use orthoses most often after stand-alone lateral interbody fusions (43%) ( $p < 0.0001$ ). The average bracing frequency after lumbar fusions (34%) was higher than the average bracing frequency after non-fusion surgeries (16%) ( $p < 0.0001$ ). The most frequently utilized brace was an off the shelf lumbar sacral orthosis (66%), and most surgeons braced patients to improve pain (42%). Of surgeons who braced, most commonly did so for 2–4 months (57%).

**Conclusion:** Most surgeon respondents did not prescribe orthoses after varying elective lumbar surgeries, and the frequency overall was lower than a similar study conducted in 2009. There continues to be inconsistencies in postoperative bracing practices. In an era striving for evidence-based practices, this is an area needing more attention.

## Introduction

Using orthoses postoperatively after spinal surgery has been thought to possibly accelerate recovery, promote arthrodesis, and reduce pain [1]. Compelling theoretical and observational evidence for the benefit of postoperative external immobilization exists [1–4]. However, the clinical utility of postoperative orthoses has long been questioned [1,5,6], and clinical series have failed to show improvement in patient outcomes with their use [6–8]. Surgeon usage of postoperative bracing has thus been mixed [9,10].

In 2009, Bible et al. surveyed 98 spine surgeons at an academic conference about their postoperative bracing preferences after elective cervical and lumbar spine surgery [10]. This referenced study found that most physicians prescribed postoperative bracing (56% across varied cervical and lumbar procedures).

More recently in 2018, Lunardini et al. conducted a similar study, surveying 83 spine surgeons about their bracing practices after elective cervical spine surgery [9]; there was no significant shift in surgeon bracing preferences compared with the cervical spine findings from Bible and colleagues almost a decade prior [9]. It is unclear whether bracing preferences after lumbar spine surgery have changed over time.

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The present study, therefore, aimed to characterize contemporary attitudes towards postoperative bracing after elective lumbar spine surgery. United States (U.S.)-based surgeons attending the 2019 Annual Meeting of the Lumbar Spine Research Society (LSRS) were surveyed. Demographic information of the respondents and specifics about bracing practices after varying elective lumbar procedures were assessed.

## Materials and methods

### Questionnaire development

A one-page questionnaire was created to assess postoperative use of bracing following seven different elective lumbar spinal surgeries (Supplemental Fig. A). First, a series of demographic background questions were asked including type of residency training (orthopaedic surgery or neurosurgery), whether they had completed fellowship, practice setting, how many years they had been in practice, and location.

For varying types of lumbar surgery, surgeons were first asked if they performed the surgery. If they performed a particular surgery, they were asked to mark if they used orthoses postoperatively. In the case respondents braced postoperatively, they were asked to identify the type of brace used, duration of use, and reason for bracing. The present study was institutional review board (IRB) approved at the authors' institution.

### Questionnaire administration

This questionnaire was first optimized and administered to spine surgeons at the authors' institution to verify accuracy and consistency of structure. It was then distributed to all attendees of the 2019 LSRS Annual Meeting. There were a small number of respondents who were trainees (residents or fellows), who were excluded. Further, the study was limited to surgeons practicing in the U.S., as it was thought that bracing patterns may vary internationally.

### Statistical analysis

The data from the questionnaires was entered into a Microsoft Excel file. Statistical testing was performed using Stata 13.0 and Microsoft Excel. Chi-squared analysis and one-way analysis of variable (ANOVA) were used to compare bracing frequencies between groups.

## Results

### Biographical information of recipients and overview

Seventy-three of 88 U.S.-based surgeons attending LSRS completed the questionnaire (83% response rate, Fig. 1). The majority of respondents were orthopaedic surgery-trained (78%), had completed fellowship (84%), and practiced in an academic setting (73%).

As a whole, there was a relatively uniform spread among questionnaire respondents with regards to duration of practice (less than 5 years: 26%, 5–10 years: 23%, 10–20 years: 23%, 20 or more years: 23%). All U.S. geographic regions were represented, while Midwest (where the conference was hosted) represented the most commonly cited region of practice (44%).

The postoperative bracing frequency averaged across all recipients and lumbar spine surgeries (and levels) was 26%. Compared to the lumbar bracing frequency in the referenced study a decade prior (49% [10]), the bracing frequency from the present study was significantly lower when calculated in a similar fashion (Fig. 2;  $p < 0.0001$ ).

In total, the majority of surgeons (60%) did not brace postoperatively after any elective lumbar spine surgery. Only 29 of 73 (40%) surgeons chose to use an orthosis postoperatively after at least one type of lumbar spine surgery. Out of this group of 29 surgeons, five surgeons chose to use an orthosis after every type of lumbar spine surgery they performed.

### Bracing practices

There were no significant differences in bracing frequencies between orthopaedic-trained and neurosurgery-trained spine surgeons (27% vs 24%,  $p = 0.79$ ) and fellowship-trained and non-fellowship-trained spine surgeons (27% vs 23%,  $p = 0.713$ ). Private practice surgeons were found to be more likely to brace than academic spine surgeons (50% vs 17%,  $p = 0.001$ ). There was no statistically significant difference in bracing frequency based on duration of practice (less than 5 years: 15%, 5–10 years: 40%, 10–20 years: 36%, 20 or more years: 18%;  $p = 0.516$ ) or across geographic regions (Midwest: 20%, Northeast: 52%, South: 23%, West: 22%;  $p = 0.901$ ).

Bracing practices by type of surgery and number of surgical levels are shown in Table 1 and Fig. 3. Respondents tended to brace most often after stand-alone lateral interbody fusions (43%) and least often after discectomies (11%), averaged across levels.

The average bracing frequency after lumbar fusions (34%) was higher than the average bracing frequency after non-fusion surgeries (16%) ( $p < 0.0001$ ). Further, bracing frequencies after lateral interbody fusions and posterior fusions with instrumentation (31% and 34%) were lower than bracing frequencies after the same surgeries without instrumentation (43% and 41%) ( $p = 0.036$  and  $p = 0.009$ , respectively).

### Type of brace

Bracing types prescribed are shown in Fig. 4. The most commonly used brace across the queried elective lumbar surgeries and levels was an off the shelf lumbar sacral orthosis (LSO) (66%). Lumbar corsets were also prescribed (28%), while custom molded LSOs were less commonly prescribed (6%).

Lumbar corsets were prescribed more commonly after non-fusion lumbar surgeries (44%) than after lumbar fusion surgeries (27%) ( $p < 0.0001$ ). Off the shelf LSOs were prescribed more frequently after lumbar fusion surgeries (68%) compared to non-fusion surgeries (48%) ( $p < 0.0001$ ). There was no discernible pattern in the prescription of custom molded LSOs between lumbar fusion and non-fusion surgeries.

When assessing specific surgeries, an off the shelf LSO was prescribed most commonly after transforaminal lumbar interbody fusion (TLIF)/posterior lumbar interbody fusion (PLIF). A lumbar corset was most commonly prescribed after a total disc arthroplasty. A custom molded LSO was most commonly prescribed after a discectomy.

### Duration of and reason for bracing

Durations of bracing recommended are shown in Table 2 and Fig. 5. Overall, for all elective lumbar spine surgeries, surgeons tended to brace their patients postoperatively for 3–8 weeks (57%), followed by 2–4 months (36%). Durations of less than three weeks (7%) or more than four months (0.8%) were chosen less frequently.

Overall, surgeons tended to brace for longer periods after lumbar fusion surgeries. Surgeons chose a bracing duration of 2–4 months more commonly after lumbar fusions (62%) compared to after non-fusions (32%) ( $p < 0.0001$ ). A shorter duration of 3–8 weeks was chosen more commonly after non-fusions (60%) compared to after fusions (30%) ( $p < 0.0001$ ).

Averaged over all elective lumbar spine surgeries (and levels), surgeons braced postoperatively most commonly in order to improve pain (42%) and slow down the patient (35%) (Table 2). Increasing fusion rate (18%) and other reasons (5%) were less commonly cited rationale for bracing after fusion surgeries. There were no discernible differences in rationale provided between non-fusion surgeries and fusion surgeries.

## Discussion

Surgeons may choose to prescribe orthoses following spine elective spine surgery, though their impact on clinical outcomes is not clear

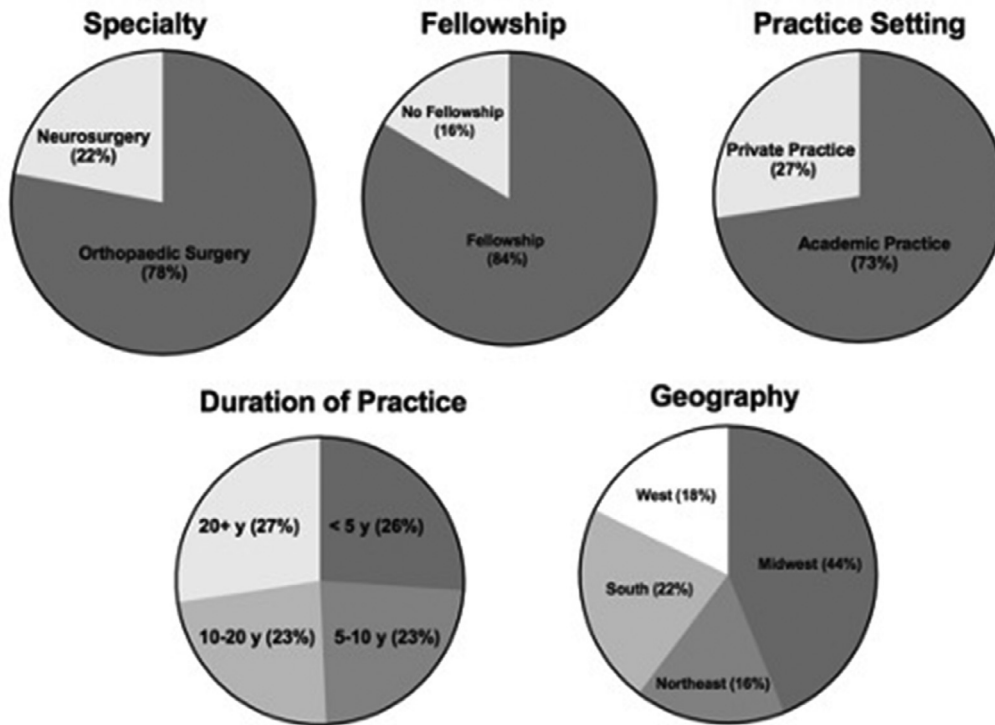


Fig. 1. Graphical depiction of surgeon breakdown (n=73) by specialty, fellowship training, practice setting, practice duration, and practice geography.

**Table 1**  
Number of surgeons performing surgery and bracing frequency (%) by type of surgery and level.

Type of surgery	1-Level		2-Level		3-Level	
	N, number of surgeons	Bracing frequency (%)	N, number of surgeons	Bracing frequency (%)	N, number of surgeons	Bracing frequency (%)
Discectomy	72	11.1	68	10.3	46	10.9
Laminectomy	72	12.5	72	13.9	72	15.3
Total disc arthroplasty	22	18.2	20	6	6	33.3
ALIF w/ posterior inst.	63	28.6	60	28.3	42	26.2
ALIF (stand-alone)	57	33.3	33	30.3	16	25
TLIF/PLIF	70	30.0	67	29.9	51	35.3
Lateral IF w/ posterior inst.	56	26.8	55	29.1	41	36.6
Lateral IF (stand-alone)	34	38.2	23	47.8	18	44.4
Posterior fusion w/ inst.	69	31.9	68	32.4	68	36.8
Posterior fusion w/o inst.	41	41.5	37	40.5	36	41.7

\*Total number of surgeons: 73.

**Table 2**  
Most frequently reported type of brace, bracing duration, and reason for bracing by type of surgery and level.

Type of surgery	1-Level			2-Level			3-Level		
	Type of brace	Bracing duration	Reason for bracing	Type of brace	Bracing duration	Reason for bracing	Type of brace	Bracing duration	Reason for bracing
Discectomy	Lumbar corset	3-8 wk	Improve pain	Lumbar corset/ off the shelf LSO	3-8 wk	Improve pain	Lumbar corset/ off the shelf LSO	3-8 wk	Improve pain
Laminectomy	Off the shelf LSO	3-8 wk	Improve pain	Off the shelf LSO	3-8 wk	Improve pain	Off the shelf LSO	3-8 wk	Improve pain
Total disc arthroplasty	Lumbar corset/ off the shelf LSO	2-4 mo	Improve pain	Lumbar corset/ off the shelf LSO	2-4 mo	Improve pain	Lumbar corset/ off the shelf LSO	3-8 wks/ 2-4 mo	Improve pain
ALIF w/ posterior inst	Off the shelf LSO	2-4 mo	Improve pain	Off the shelf LSO	2-4 mo	Improve pain	Off the shelf LSO	2-4 mo	Improve pain
ALIF (stand-alone)	Off the shelf LSO	2-4 mo	Slow down Pt	Off the shelf LSO	2-4 mo	Improve pain	Off the shelf LSO/lumbar corset	2-4 mo	Improve pain
TLIF/PLIF	Off the shelf LSO	2-4 mo	Slow down Pt	Off the shelf LSO	2-4 mo	Improve pain/ slow down Pt	Off the shelf LSO	2-4 mo	Improve pain/ slow down Pt
Lateral IF w/ posterior inst.	Off the shelf LSO	2-4 mo	Improve pain	Off the shelf LSO	2-4 mo	Improve pain	Off the shelf LSO	2-4 mo	Improve pain
Lateral IF (stand alone)	Off the shelf LSO	2-4 mo	Improve pain	Off the shelf LSO	2-4 mo	Improve pain	Off the shelf LSO	2-4 mo	Improve pain
Posterior fusion w/ inst.	Off the shelf LSO	2-4 mo	Improve pain	Off the shelf LSO	2-4 mo	Improve pain	Off the shelf LSO	2-4 mo	Improve pain
Posterior fusion w/o inst.	Off the shelf LSO	2-4 mo	Improve pain/ slow down Pt	Off the shelf LSO	2-4 mo	Improve pain	Off the shelf LSO	2-4 mo	Improve pain

**Overall Bracing Frequency for Lumbar Spine Surgeries by Study**

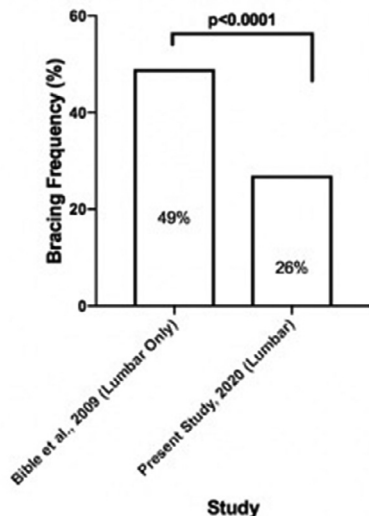


Fig. 2. This bar graph compares bracing frequencies for lumbar surgeries (overall) in Bible et al., 2009 vs. lumbar surgeries (overall) in the present study. This difference was statistically significantly.

[6,11]. Approximately ten years ago, Bible et al. found that the frequency of postoperative bracing after spine surgery was 56% (49% after lumbar surgery and 63% after cervical surgery) [10]. About a decade later, Lunardini et al. found that the postoperative bracing frequency after cervical spine surgery had remained stable at 67% [9].

The present questionnaire-based study, therefore, aimed to determine contemporary perspectives in the U.S. on postoperative bracing after elective lumbar surgery. In contrast to the follow-up cervical study quoted above [9], the incidence of lumbar bracing was notably lower than the results of Bible and colleagues [10]. Over a decade, there has

been a 23% decrease (from 49% to 26%;  $p < 0.0001$ ) in surgeons who routinely use orthoses after the operative treatment of degenerative conditions affecting the lumbar spine.

There were no differences in bracing preference based on specialty (orthopaedic surgery or neurosurgery), fellowship training (yes or no), duration in practice, or geographic location of practice. These speak to the relative consistency of practice across these multiple parameters. On the other hand, bracing frequencies tended to be higher among private practice surgeons, compared to academic surgeons. Although the reason for this cannot be determined, there is the question of financial incentives based on model of practice.

In terms of procedure-specific considerations, postoperative bracing was reported less frequently after non-fusion procedures (16%) than after fusion procedures (34%,  $p < 0.0001$ ), similar to what had been reported by Bible et al. in 2009 [10]. Further, consistent with the fact that no fusion was being performed, the most common reason cited for bracing of this population was to improve pain control.

For fusion procedures, there was a higher reported use of postoperative bracing. Rates of bracing were higher for non-instrumented fusions, which matches findings from a similar study performed in Belgium-based spine surgeons [12]. Interestingly, the most commonly cited reasons for bracing in these patients was reported to be pain reduction and slowing down the patient. This speaks to increased confidence in the ability of instrumentation to facilitate fusion and more consideration to other patient factors than had historically been considered. However, it is worth noting that a recent systematic review assessed four previously conducted randomized controlled trials, and determined that postoperative orthoses have no effect on pain improvement [13].

Respondents tended to brace patients for a longer duration after lumbar fusions when compared with non-fusion lumbar surgeries, which was similar to findings by Bible et al. [10]. Overall, surgeons cited 3–8 weeks as the most common length of time to brace patients postoperatively after elective non-fusion lumbar spine surgery and 2–4 mo as the most common length of time to brace patients after elective lumbar fu-

**Bracing Frequencies by Lumbar Surgery and Level**

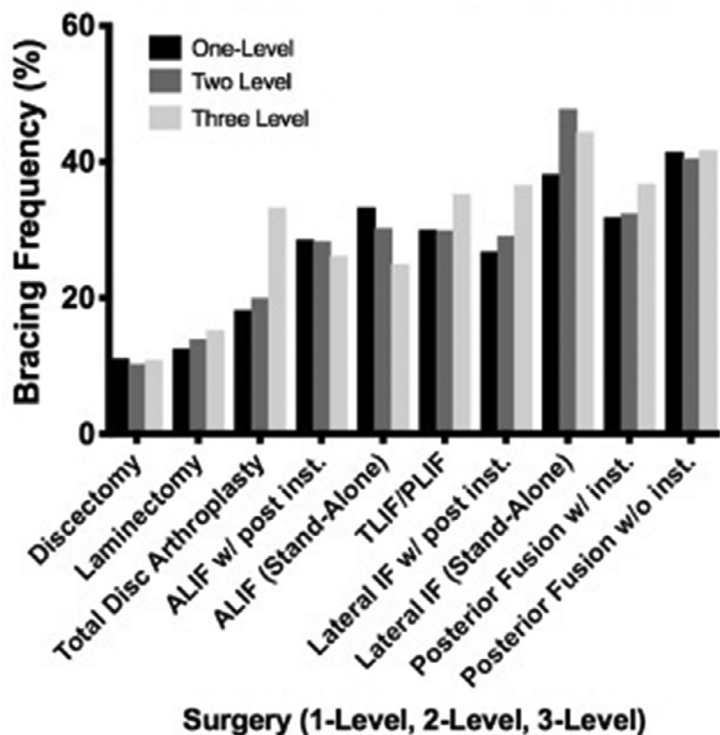


Fig. 3. Bracing frequency (percentage of surgeons bracing) by type of surgery and number of level(s). This percentage represents the number of surgeons choosing to brace divided by the number of surgeons performing that particular surgery. Non-fusion surgeries are organized on the left, while lumbar fusions are organized towards the right, in terms of increasing bracing frequencies.

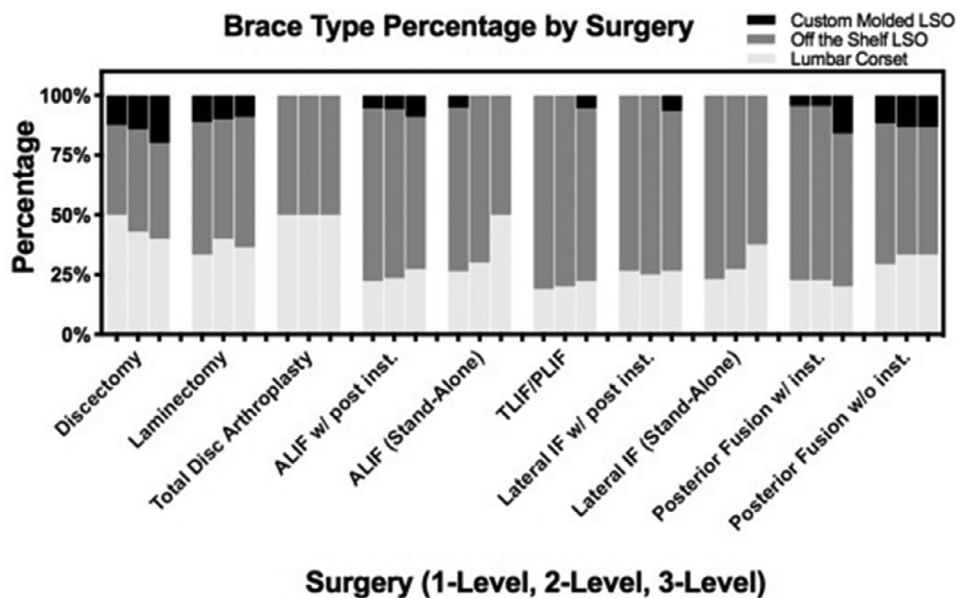


Fig. 4. Of all the surgeons choosing to brace after each lumbar surgery, the percentages of the types of braces used are represented in this stacked column graph.

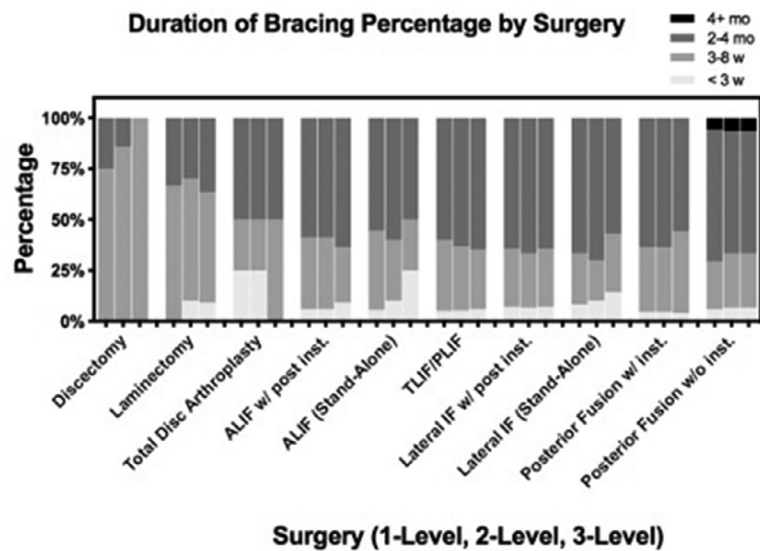


Fig. 5. Of all the surgeons choosing to brace after each lumbar surgery, the percentages of the preferred duration of bracing used are represented in this stacked column graph.

sions. When compared with the referenced study from a decade prior as well as more recent literature [10,12], there appears to be no uniform consensus on the preferred duration of bracing.

There are several limitations to the present study. Most notably, the questionnaire respondents may not be fully representative of national opinions as surgeons at an academic national conference. As with any questionnaire study, there is also the possibility of response bias [14,15], but it is noted that the present study had a relatively high response rate of 83%. There is the possibility that patient and surgical variables, beyond what was questioned, impact bracing choices that were not identified by the questionnaire. Finally, the sample size of the survey precluded comparisons of bracing practices by number of operative levels.

Overall, the present study identified a trend away from using postoperative orthoses. Of the surgeons who do brace their patients postoperatively, most do so for pain improvement and typically tend to use an off the shelf LSO. Nonetheless, there are inconsistencies of usage of often costly orthoses that need further evaluation in this era of evidence-based medicine.

**Declarations of Competing Interests**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**Supplementary materials**

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.xnsj.2021.100055.

**References**

- [1] Connolly PJ, Grob D. Bracing of patients after fusion for degenerative problems of the lumbar spine – yes or no?. In: Spine (Phila Pa 1976), 23; 1998. p. 1426–8.
- [2] Johnson RM, Hart DL, Simmons EF, Ramsby GR, Southwick WO. Cervical orthoses. A study comparing their effectiveness in restricting cervical motion in normal subjects. J Bone Joint Surg Am 1977;59(3):332–9.
- [3] Miller CP, Bible JE, Jegede KA, Whang PG, Grauer JN. Soft and rigid collars provide similar restriction in cervical range of motion during fifteen activities of daily living. Spine (Phila Pa 1976) 2010;35(13):1271–8.

- [4] Podolsky S, Baraff LJ, Simon RR, Hoffman JR, Larmon B, Ablon W. Efficacy of cervical spine immobilization methods. *J Trauma* 1983;23(6):461–5.
- [5] Schott C, Zirke S, Schmelzle JM, Kaiser C, Fernandez LA. Effectiveness of lumbar orthoses in low back pain: review of the literature and our results. *Orthop Rev* 2018;10(4):7791.
- [6] Yee AJ, Yoo JU, Marsolais EB, Carlson G, Poe-Kochert C, Bohlman HH, et al. Use of a postoperative lumbar corset after lumbar spinal arthrodesis for degenerative conditions of the spine. A prospective randomized trial. *J Bone Joint Surg Am* 2008;90(10):2062–8.
- [7] Soliman HAG, Barchi S, Parent S, Maurais G, Jodoin A, Mac-Thion J. Early impact of postoperative bracing on pain and quality of life after posterior instrumented fusion for lumbar degenerative conditions: a randomized trial. *Spine (Phila Pa 1976)* 2018;43(3):155–60.
- [8] Fujiwara H, Makino T, Yonenobu K, Moriguchi Y, Oda T, Kaito T. Efficacy of lumbar orthoses after posterior lumbar interbody fusion—a prospective randomized study. *Medicine* 2019;98(15):e15183.
- [9] Lunardini DJ, Mauser NS, Krag MH, Lee JY, Donaldson WH, Kang JD. Cervical bracing practices after degenerative cervical surgery: a survey of Cervical Spine Research Society members. *Spine J* 2018;18(10):1950–5.
- [10] Bible JE, Biswas D, Whang PG, Simpson AK, Rehtine GR, Grauer JN. Postoperative bracing after spine surgery for degenerative conditions: a questionnaire study. *Spine J* 2009;9(4):309–16.
- [11] Zhu MP, Tetreault LA, Sorefan-Mangou F, Garwood P, Wilson JR. Efficacy, safety, and economics of bracing after spine surgery: a systematic review of the literature. *Spine J* 2018;18(9):1513–25.
- [12] Bogaert L, Wambeke PV, Thys T, Swinnen TW, Dankaerts W, Brumagne S, et al. Postoperative bracing after lumbar surgery: a survey amongst spinal surgeons in Belgium. *Eur Spine J* 2019;28(2):442–9.
- [13] Nasi D, Dobran M, Pavesi G. The efficacy of postoperative bracing after spine surgery for lumbar degenerative diseases: a systematic review. *Eur Spine J* 2020;29(2):321–31.
- [14] Mazor KM, Clauser BE, Field T, Yood RA, Gurwitz JH. A demonstration of the impact of response bias on the results of patient satisfaction surveys. *Health Serv Res* 2002;37(5):1403–17.
- [15] Choi BCK, Pak AWP. A catalog of biases in questionnaires. *Prev Chronic Dis* 2005;2(1):A13.