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Spinal fusion for chronic low back pain: No consensus in clinical decision making

Results of a nationwide survey among spine surgeons

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Article summary

Article focus

- What is the level of professional consensus among spine surgeons regarding spinal fusion surgery for chronic low back pain?
- How are tests for patient selection appreciated and to what extent are they used in clinical practice?
- Are prognostic patient factors incorporated in the process of surgical decision making for chronic low back pain?

Key messages

- In clinical practice there is no professional consensus on surgical treatment strategy for chronic low back pain.
- Prognostic patient factors as well as tests for patient selection are not consistently used in clinical decision making for spinal fusion.
- Because of a lack of consensus on spinal fusion strategy for chronic low back pain in clinical practice, no guidelines for proper patient counselling can be installed at present.

Strengths and limitations

A survey among physicians provides valuable insight in the actual decision making process in clinical practice. Understanding contributory factors in treatment strategy may help in the creation of consensus guidelines.

The introduction of an interviewer bias could be avoided by the use of a neutral intermediary instead of direct questions from peers in spine surgery.

This study focussed on surgeon members of the Dutch Spine Society whose practice may not reflect that of all surgeons performing spinal fusion for chronic low back pain. Moreover, no information on conservative treatment options was acquired.

To define consensus we chose for uniformity of opinion of at least 70%, which we considered to be sufficient for implementation in guidelines. Such a cut-off level remains arbitrary.

Abstract

Objectives To assess the use of prognostic patient factors and predictive tests in clinical decision making for spinal fusion in patients with chronic low back pain.

Design and setting Nationwide survey among spine surgeons.

Participants Surgeon members of the Dutch Spine Society were questioned on their surgical treatment strategy for low back pain.

Main outcome measures The surgeons' opinion on the use of prognostic patient factors and predictive tests for patient selection, were addressed on Likert scales and the degree of uniformity was assessed. In addition, the influence of surgeon specific factors on clinical decision making was determined.

Results The comments from 62 surgeons (70% response rate) were analysed. Forty-four surgeons (71%) had extensive clinical experience. There was a statistically significant lack of uniformity of opinion in 7 of the 11 items on prognostic factors and 8 of the 11 items on predictive tests, respectively. Imaging was valued much higher than predictive tests, psychological screening, or patient preferences ($p<0.01$). Apart from the use of discography and long multi-segment fusions, differences in training or clinical experience did not appear to be of significant influence on treatment strategy.

Conclusion The present survey consistently showed a lack of consensus among surgeons. Prognostic patient factors were not consistently incorporated and the large variation in decision making prevents the creation of consensus guidelines. Despite high levels of training and continuous medical education, decision making for spinal fusion to treat chronic low back pain does not have a uniform evidence base in clinical practice.

Introduction

Chronic low back pain has become one of the main causes of disability in the industrialised world with reported life-time prevalences of up to 85%[1]. In the Netherlands, a small Western European country (16.5 million inhabitants) with a relatively high rate of spine surgery[2], the annual costs of back pain were estimated at 4.4 billion euros, which are mainly employment-related costs (lost productivity due to work absenteeism)[3].

Spinal fusion of a painful or degenerative segment can be beneficial to some patients, but it remains a controversial treatment[4,5]. In the first Cochrane review in 1999, no evidence on the effectiveness of fusion for lumbar degenerative disc disease or low back pain was found as compared to natural history, placebo or conservative treatment[6]. In the updated Cochrane review in 2005[7], two randomized controlled trials (RCT) were included. First, a Swedish trial reported a better outcome of patients treated with spinal fusion compared to patients who received standard conservative care[8], although at longer follow-up this beneficial effect attenuated[9]. Next, a Norwegian RCT that compared fusion surgery to cognitive behavioural based exercise therapy[10] showed similar results for both treatment modalities at 1 year follow-up. Similarly, in the more recent British spine stabilization trial, no clear evidence was found that spinal fusion was more beneficial than an intensive rehabilitation program at 2 years follow-up[11]. Moreover, fusion had a much higher complication rate in this trial and appeared to be less cost-effective than intensive rehabilitation[12,13].

Proper patient selection may improve the outcome of fusion for which several prognostic factors and predictive tests have been reported[4,14-19]. However, epidemiological research reveals large variation in fusion rates between countries and even between different regions within the same country[20,21], suggesting a poor level of professional consensus. Understanding contributory factors in treatment strategy of surgeons, may clarify some of these observed variations and help create consensus guidelines for clinical decision making.

Therefore, we conducted a national survey among spine surgeons in the Netherlands with the aim to assess the surgeons' opinion on prognostic patient factors known from the literature, as well as the use of predictive tests for spinal fusion in clinical practice. In addition, the degree of uniformity in decision making was determined.

Materials and Methods

A 25-question survey (see Appendix) was sent by mail to all surgeon members of the Dutch Spine Society, by Memic, a Center for Data and Information Management, University of Maastricht, the Netherlands (www.memic.unimaas.nl). In an accompanying letter the background rationale for the enquiry, as well as the voluntary and confidential nature was stressed and the surgeons were reassured that individual comments would remain anonymous.

The questionnaire concerned the selection for spinal fusion of patients with low back pain caused by degenerative lumbar disc disease without signs of neurological deficit, spinal stenosis, deformity or spondylolisthesis and in the absence of trauma, tumor or infections. This group was further referred to as chronic low back pain patients. For clarity the questionnaire had first been evaluated and revised by a clinical researcher and two orthopaedic surgeons. Most questions could be answered according to a 5-point Likert scale. Surgeon specific factors (e.g., discipline, clinical experience), the influence of patient factors (prognostic factors as reported in literature), and the use of tests for patient selection (e.g., provocative discography), were addressed. The respondents were specifically asked to rely on their own individual opinion and management in practice.

Those who had not responded received a second call by mail after two months, and final inclusion was set another two months later. Data were entered into Excel™ (Microsoft, Corp., Redmond, WA) and all inconsistencies were resolved. Unanswered questions were coded as missing. Descriptive statistics was used in which all frequencies were based on the number of valid responders.

For analysis the answers on the 5-point Likert scale were merged into one intermediate option (“neutral”) and 2 opposite categories (“always/almost always” versus “never/almost never” and “fully/globally agree” versus “globally/fully disagree”). The data were processed with Statistical Package for the Social Sciences software (SPSS, Inc., Chicago, IL). Pearson’s chi-square test was used to evaluate whether surgeon specific factors were associated with clinical decision making. Uniformity of opinion was defined to be present if 70% or more of the respondents answered similarly. In other words, there was no consensus if the proportion of the largest category was statistically significantly lower than 70% (Pearson’s chi-square test). Differences in mean values rating the impact of factors on decision making,

were tested by Independent t-test for equality of means. The level of significance was set at $p<0.05$.

Results

Nine of the 150 surveyed surgeons (89 orthopaedic surgeons and 61 neurosurgeons) had ended their professional career and 9 respondents stated not to perform spinal surgery anymore. Of the remaining 132 active spine surgeons, 93 (70%) completed and returned the questionnaire. Thirty-one of the 93 respondents (33%) declared not to perform spinal fusion for low back pain and were excluded from further analysis. The characteristics of the final group of 62 respondents are listed in Table 1. The level of experience for neurosurgeons and orthopaedic surgeons was equal: 11 of 16 (69%) versus 33 of 46 (72%) worked ten years or more in clinical practice, respectively.

Prognostic factors

The respondents' comments on prognostic factors are listed in Table 2. For 7 of the 11 items there was no consensus (significantly less than 70% uniformity of opinion). More than 70% of the respondents would fuse patients over 60 years old for back pain. Years of clinical experience or specialty did not appear to be of influence (p=0.504, and p=0.690, respectively).

Only 1 of 15 neurosurgeons fused patients below 20 for back pain, versus 14 of 46 orthopaedic surgeons (p=0.063).

Eighteen orthopaedic surgeons performed fusion of 3 or more levels for low back pain, whereas no neurosurgeon did (p=0.003).

Tests for patient selection

The surgeons' appreciation and use of predictive tests are listed in Tables 3a and 3b, respectively. Apart from MRI, there was no uniformity regarding the value of these tests for clinical decision making.

Mainly orthopaedic surgeons (21 of 46, versus 2 of 16 neurosurgeons, p=0.025) considered provocative discography to be a valid predictor of fusion. Spine surgeons working in general hospitals (20 of 43), appeared to believe more in the test than academic surgeons did (3 of 18, p=0.028). There was no relation with clinical experience (p=0.406). Apart from the use of discography, differences in discipline or clinical experience did not appear to be of significant influence on treatment strategy.

In the evaluation of chronic low back pain no other predictive tests than those mentioned in Tables 3a and 3b were used on a regular basis.

Individual decision making in clinical practice

Figure 1 shows the importance of predictive tests and prognostic factors for clinical decision making as rated on a scale from 0 to 10. Patient history and imaging were valued significantly higher than predictive tests, psychological screening or patient preferences (all respective comparisons: $p<0.01$, Independent t-test).

The impact of surgeon specific factors on treatment strategy is listed in figure 2. Experience was rated highest (mean ± sd, 8.0 ± 1.7), as compared to findings from literature (7.7 ± 1.1, $p=0.26$), scientific courses (7.3 ± 1.4, $p=0.01$), and training (6.8 ± 2.8, $p<0.01$).

Twenty-seven (45%) surgeons responded to have a protocol for decision making to which they frequently or always adhered. Of those 35 respondents who did not have such a protocol, 23 (68%) replied that there should be guidelines. In other words, 50 respondents (83%) felt that clinical guidelines in the management of CLBP patients are prerequisite.

Discussion

This study presents the results of the first nationwide survey among spine surgeons regarding clinical decision making for spinal fusion in patients with chronic low back pain. The response rate was adequate (70%) and the majority of the respondents (71%) had extensive clinical experience in spinal surgery. A considerable heterogeneity in the use and appreciation of predictive tests was observed. Prognostic patient factors were not consistently incorporated in clinical decision making.

Strengths and weaknesses

This survey focused on surgeon members of the Dutch Spine Society whose practice may not reflect that of all surgeons performing spinal fusion for low back pain. This may have produced a selection bias. It is reasonable, however, to expect that surgeons with a special interest in the spine are exactly those to be most aware of guidelines and research findings in the field.

To define consensus we chose for uniformity of opinion of 70% or more of the respondents. We felt that this level of agreement should be sufficient for implementation in guidelines. Such a cut-off level remains, of course, arbitrary and debatable.

The introduction of an interviewer bias could be avoided by employing Memic, Center for Data and Information Management, as a neutral intermediary. In this way, surgeons could feel free to answer what they personally felt or practiced, as opposed to what they thought would be considered “correct”.

For statistical analysis the 5-point Likert scale responses were merged into 3 categories, which may have simplified the respondents’ opinion on the management of low back pain in practice.

Comparison with related research

Older age is an acknowledged predictor of poor outcome[14]. Nevertheless, almost three quarters (73%) of the respondents fused patients above 60 for low back pain. Despite the fact that 2 or 3-level fusions have been reported to have proven higher rates of pseudarthrosis with lower patient satisfaction as compared to single level fusions[5,14], over 30% of the respondents would consider fusion of 3 levels or more.

Although fusion surgery is not recommended unless 2 years of conservative treatment have failed[22], 63% of the surgeons felt that less than 1 year of conservative therapy is enough to consider fusion.

Obesity is an independent risk factor for low back pain, and surgery in these patients is significantly associated with major complications, such as thrombo-embolism and infection[19]. Nevertheless, 53% of the respondents would operate for chronic low back pain on obese patients and 24% on the morbid obese. Less than half of the surgeons (47%) consistently referred overweight patients to a dietician.

There was no consensus regarding smoking, which is known to be an independent risk factor for low back pain[15] and associated with worse results of spinal fusion[12]. About 41% would fuse heavy smokers, whereas 48% would not operate smokers for back pain.

Psychologically stressful work has been associated with low back pain and disability[17], and it has been reported that psychological distress, depressive mood and somatisation lead to an increased risk of chronicity[18]. In addition, presurgical depression is associated with worse patient outcome after lumbar fusion[14]. Only 16% of the respondents referred patients routinely for psychological screening and 39% never referred for this purpose at all.

There is strong evidence that clinical interventions are not effective in returning patients back to work once they have been off work for a longer time[22]. About half of the respondents agreed that the work status of patients with low back pain affects outcome considerably and 69% acknowledged that litigation or workers' compensation are of great influence on decision making, as they have been associated with persisting pain and disability[17].

Two-thirds (66%) of the respondents considered findings on plain radiographs and MRI-scan alone to be insufficient for surgical decision making (Table 3a). This is in accordance with the literature indicating that degenerative or black discs on MRI do not appear to have a strong clinical relevance[23,24] and that there is no correlation between radiographic signs of degeneration and clinical outcome[25].

Opinion differed about trial immobilization with a pantaloon cast: 40% of the respondents agreed that it is a valuable test and 36% disagreed. This resembles conflicting reports from the literature claiming that the test is not predictive of fusion outcome[26] or that only in highly selected patient groups the pantaloon cast test may be of value[27].

Provocative discography is a controversial test, which is highly variable in chronic pain patients and can also be positive in pain-free individuals[28]. Its value in predicting the outcome of fusion for low back pain is debated [16,29], which was reflected in the completely contradictory respondents' opinions. Trial immobilization with a temporary external fixator is known for its high complication rate[30] and because of ambiguous results, its use is not recommended[31]. In the present survey, external fixation was not frequently used (94% never used it) and only 13% believed in its predictive value. Lumbar facet injections have been reported not to be predictive of either arthrodesis or nonsurgical treatment of back pain[32]. Accordingly, only 8% used facet joint blocks on a regular basis as a predictor of spinal fusion.

Clinical relevance and implications for clinicians and policymakers

The lack of consensus among spine surgeons as found in the present survey could not be explained by differences in training or clinical experience. Apart from the use of discography and long multilevel fusions, the surgeons' discipline and years in practice did not appear to be of significant influence on treatment strategy. More likely, the observed heterogeneity of opinion reflects the absence of consistent high quality evidence for the validity of prognostic factors and predictive tests[33]. As there is no generally acknowledged superior approach for low back pain, substantial variations that exist between practices are caused by clinical uncertainty as to what constitutes the best of care.

In a survey among expert spine surgeons, bad patient selection and disproportionate preoperative expectations were considered to be the major factors for poor outcome in spinal surgery[34]. At present, consistent evidence on tests or tools that reliably predict the outcome of fusion is lacking[35]. Moreover, to provide a reliable estimation of the effectiveness of surgery, preferences of the individual patient, as well as psychological and social factors that may affect outcome, should be assessed[36]. To achieve realistic patient expectations of surgery, good patient counselling should be evidence based, i.e., determined by the best available clinical evidence from systematic research[37], combined with the individual surgeon's expertise and expectation of treatment success[38]. As the present survey shows, prognostic factors are not consistently incorporated at all in the surgical decision making process. Lack of consensus among surgeons hampers the implementation of clinical guidelines, which are needed for proper patient counselling.

Future research should thus focus on identifying a subgroup of patients for whom spinal fusion is a predictable and effective treatment. If the results of fusion could be improved by better patient selection, there could be a role for spinal fusion as the treatment of choice for this particular subgroup of patients. A reliable prediction of surgical outcome, combined with the implementation of individual patient factors, would enable the instalment of clinical guidelines for surgical decision making. Such guidelines are needed, not only for patient counselling, but also for communication with insurers, policymakers and other health care providers who are involved in the management of chronic low back pain.

Conclusion

The present survey consistently showed a lack of consensus among spine surgeons in surgical decision making. Despite high levels of training and continuous medical education, patient selection for fusion surgery in the treatment of chronic low back pain does not have a uniform evidence base in clinical practice.

Contributions of authors

Paul Willems:	Conception and design of the study
	Acquisition, analysis and interpretation of data
	Drafting the article
	Approval of the final version to be published
Rob de Bie:	Design of the study
	Acquisition and analysis of data
	Revising the article
	Approval of the final version to be published
Cumhur Öner:	Design of the study
	Analysis and interpretation of data
	Revising the article
	Approval of the final version to be published
René Castelein:	Design of the study
	Analysis and interpretation of data
	Revising the article
	Approval of the final version to be published
Marinus de Kleuver:	Conception and design of the study
	Analysis and interpretation of data
	Revising the article
	Approval of the final version to be published

Declarations

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All authors have completed the Unified Competing Interest form atwww.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

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Table 1 Characteristics of the 62 respondents

	Orthopaedic surgeons (n)	**Neurosurgeons (n)**	**All respondents (n)**
No. of respondents	46	16	62
Age			
< 50 years	22	10	32
≥ 50 years	24	6	30
Clinical experience			
< 10 years	13	5	18
≥ 10 years	33	11	44
Type of hospital			
University/specialized	13	5	18
General	33	11	44
No. of fusions for CLBP/year			
1-10	24	9	33
10-25	9	6	15
25-50	7	1	8
≥ 50	6	0	6

Abbreviation: CLBP = chronic low back pain; n = number

Table 2 Respondents' opinion to what extent patient-specific prognostic factors influence their clinical decision making in the treatment of CLBP. The numbers listed are percentages of valid responses

Maximum number of levels for fusion	1 level	2 levels	3 or more levels	p-value*
	18 (30.5)	**23 (39.0)**	**18 (30.5)**	**p<0.001**
Minimum age patient	Under 20 yrs	20 to 30 yrs	30 yrs or more	
	15 (24.6)	**25 (41.0)**	**21 (34.4)**	**p<0.001**
Maximum age patient	40 to 50 yrs	50 to 60 yrs	60 yrs or more	
	5 (8.1)	**12 (19.4)**	**45 (72.5)**	**NS**
Minimal length conservative therapy	Less than 6 mo	6 mo to 1 yr	1 yr or more	
	3 (4.8)	**36 (58.1)**	**23 (37.1)**	**NS**
Maximum Body Mass Index (BMI)	Under 31	31 to 37	37 or more	
	29 (46.8)	**18 (29.0)**	**15 (24.2)**	**p<0.001**
Maximum number of cigarettes / day	0	1 to 20	20 or more	
	29 (47.5)	**7 (11.4)**	**25 (40.9)**	**p<0.001**
Referral overweight patients to dietician	Always	Sometimes	Never	
	29 (46.8)	**20 (32.3)**	**13 (21.0)**	**p<0.001**
Psychological screening referral	Always	Sometimes	Never	
	10 (16.2)	**28 (45.2)**	**24 (38.7)**	**p<0.001**
Different criteria for primary DDD versus prior spine surgery	Agree	Neutral	Disagree	
	44 (71.0)	**8 (12.9)**	**10 (16.1)**	**NS**
Work status affects outcome	Agree	Neutral	Disagree	
	29 (46.7)	**17 (27.4)**	**16 (25.9)**	**p<0.001**

Litigation procedures affect outcome	Agree	Neutral	Disagree	
	43 (69.3)	**9 (14.5)**	**10 (16.2)**	**NS**

Abbreviation: DDD = degenerative disc disease, NS = not significant.

*Chi-square test: $p<0.05$ means significantly less than 70% consensus, NS implies uniformity.

Table 3a Respondents' opinion on predictive tests for clinical decision making. The numbers listed are valid responses and respective percentages

Predictive test	Agree (%)	Neutral (%)	Disagree (%)	p-value*
MRI sufficient for decision making	10 (16.1)	11 (17.7)	41 (66.1)	NS
Cast immobilization valuable test	25 (40.3)	15 (24.2)	22 (35.5)	<0.001
Cast immobilization too unpleasant	11 (17.7)	16 (25.8)	35 (56.5)	0.028
PD proven valuable test	23 (37.7)	16 (26.2)	22 (36.0)	<0.001
PD too many complications	3 (4.9)	14 (23.0)	44 (72.1)	NS
TETF valuable test	8 (13.4)	33 (55.0)	19 (31.6)	0.011
TETF too many complications	20 (32.7)	31 (50.8)	10 (16.4)	0.001

Abbreviations: MRI = magnetic resonance imaging, PD = provocative discography, TETF = temporary external transpedicular fixation, NS = not significant.

*Chi-square test: p<0.05 means significantly less than 70% consensus, NS implies uniformity.

Table 3b The use of predictive tests by the surgeons in clinical practice. The numbers listed are valid responses and their respective percentages

Use of test	Always (%)	Sometimes (%)	Never (%)	p-value*
Facet joint blocks	5 (8.1)	32 (51.6)	25 (40.3)	0.002
Cast immobilization	20 (32.8)	23 (37.7)	18 (29.6)	<0.001
PD	25 (42.4)	10 (16.9)	24 (40.7)	<0.001
TETF	0 (0.0)	3 (4.9)	58 (95.1)	NS

Abbreviations : PD = provocative discography, TETF = temporary external transpedicular fixation, NS = not significant.

*Chi-square test: p<0.05 means significantly less than 70% consensus, NS implies uniformity.

Appendix

Questionnaire on decision making for lumbar spinal fusion in chronic low back pain patients

1	What is your discipline?	**1**	Neurosurgery
		2	Orthopaedic surgery
		3	Other, ……
2	What is your age?	**1**	Under 30 years
		2	30 to 40 years
		3	40 to 50 years
		4	50 to 60 years
		5	60 years or older
3	Since when do you perform spinal surgery?	**1**	Less than 1 year
		2	1 to 5 years
		3	5 to 10 years
		4	10 to 15 years
		5	15 years or more
4	In what kind of hospital do you work? *(more than one answer possible)*	**1**	University hospital
		2	General teaching hospital
		3	General nonteaching hospital
		4	Specialized hospital
		5	Other, ……

The next questions concern the indication for lumbar spinal fusion (or lumbar total disc replacement if appropriate) in patients with low back pain caused by degenerative lumbar disc disease without signs of neurological deficit, spinal stenosis, deformity or spondylolisthesis and in the absence of trauma, tumor, infections or other consuming illnesses, further to be referred to as chronic low back pain (CLBP) patients

5	How many lumbar fusions do you perform each year in CLBP patients?	**1**	0
		2	1 to 10
		3	10 to 25
		4	25 to 50
		5	50 or more
6	How many total disc replacements do you perform each year in CLBP patients?	**1**	0
		2	1 to 10
		3	10 to 25
		4	25 to 50
		5	50 or more
7	What is for you the maximum number of levels to be fused in CLBP patients?	**1**	1
		2	2
		3	3
		4	4 or more

		5	No maximum
8a	What is for you the absolute minimum age of a CLBP patient to be considered for lumbar fusion?	**1** **2** **3** **4** **5**	Under 20 years 20 to 30 years 30 to 40 years 40 years or more No minimum age
8b	What would be for you the absolute maximum age of a CLBP patient to be considered for lumbar fusion?	**1** **2** **3** **4** **5**	Under 40 years 40 to 50 years 50 to 60 years 60 years or older No maximum age
9	How long should a CLBP patient at least have followed conservative therapy in order to be considered for lumbar fusion?	**1** **2** **3** **4** **5**	0 to 6 months 6 months to 1 year 1 to 2 years 2 years or longer No minimum
10a	What would be for you the maximum weight of a 1.80 meter long male CLBP patient in order to be considered for lumbar fusion?	**1** **2** **3** **4** **5**	Less than 80 kg 80 to 100 kg 100 to 120 kg 120 kg or more No maximum weight
10b	Do you send overweight CLBP patients to a dietician before considering lumbar fusion?	**1** **2** **3** **4** **5**	Always Frequently Sometimes Seldom Never
11	What is for you the maximum number of cigarettes a CLBP patient is allowed to smoke in order to be considered for lumbar fusion?	**1** **2** **3** **4** **5**	0 cigarettes per day 1 to 10 cigarettes per day 10 to 20 cigarettes per day 20 or more cigarettes per day No maximum
12	Do you send CLBP patients for psychological screening before considering lumbar fusion?	**1** **2** **3** **4** **5**	Always Frequently Sometimes Seldom Never

You are requested to indicate whether you agree or not with the following statements.

		Fully agree	Partially agree	Neutral	Partially disagree	Fully disagree
13	The preoperative selection criteria for CLBP patients who had spine surgery before are substantially different from those for CLBP patients without prior spine surgery.	**1**	**2**	**3**	**4**	**5**
14	The work status (Full or partial disability, long term sick leave) of a CLBP patient is of great influence on your decision to perform lumbar fusion.	**1**	**2**	**3**	**4**	**5**
15	Involvement in litigation or workers compensation processes is of great influence on your decision making.	**1**	**2**	**3**	**4**	**5**
16	Plain radiographs and MRI-findings in CLBP patients are sufficient for your decision to perform lumbar fusion.	**1**	**2**	**3**	**4**	**5**

The next statements and questions concern clinical tests that may be helpful in decision making for lumbar fusion in CLBP patients.

17a	Trial immobilization in a plaster jacket or pantaloon cast is a proven valuable test for decision making in CLBP patients.	**1**	**2**	**3**	**4**	**5**
		Always	Frequently	Sometimes	Seldom	Never
17b	Do you use this trial immobilization in a cast in CLBP patients?	**1**	**2**	**3**	**4**	**5**
		Fully agree	Partially agree	Neutral	Partially disagree	Fully disagree
17c	Trial immobilization in a cast is too unpleasant for the patient to be executed.	**1**	**2**	**3**	**4**	**5**

18a	Provocative discography is a proven valuable test for decision making in CLBP patients.	Fully agree **1**	Partially agree **2**	Neutral **3**	Partially disagree **4**	Fully disagree **5**
18b	Are CLBP patients in your practice selected for fusion by provocative discography?	Always **1**	Frequently **2**	Sometimes **3**	seldom **4**	Never **5**
18c	Provocative discography has too many complications to be executed.	Fully agree **1**	Partially agree **2**	Neutral **3**	Partially disagree **4**	Fully disagree **5**
19a	Temporary external transpedicular fixation (TETF) of one or more segments is a proven valuable for decision making in CLBP patients.	Fully agree **1**	Partially agree **2**	Neutral **3**	Partially disagree **4**	Fully disagree **5**
19b	Do you use TETF as a tool for decision making in CLBP patients?	Always **1**	Frequently **2**	Sometimes **3**	Seldom **4**	Never **5**
19c	TETF has too many complications to be executed in CLBP patients.	Fully agree **1**	Partially agree **2**	Neutral **3**	Partially disagree **4**	Fully disagree **5**
20	Are CLBP patients in your practice selected for fusion by facet joint blocks?	Always **1**	Frequently **2**	Sometimes **3**	Seldom **4**	Never **5**

21	Do you use other tests as a selective tool for lumbar fusion in CLBP patients?	**1**	No
		2	Yes, …… …… ……

		0 to 10
Could you rate on a scale ranging from 0 (no importance) to 10 (maximum importance) how important you consider each of the following items as a selective tool for lumbar fusion in CLBP patients		
22a	Plain radiographs	……
22b	MRI-scan	……
22c	Bone scintigraphy	……
22d	History	……
22e	Physical examination	……
22f	Psychological screening	……
22g	Patient's preferences	……
22h	Facet joint blocks	……
22i	Trial immobilization by pantaloon cast	……
22j	Lumbar provocative discography	……
22k	Temporary external transpedicular fixation	……

		0 to 10
Could you rate on a scale ranging from 0 (no influence) to 10 (maximal influence) to what extent your policy regarding the operative management of CLBP patients has been influenced by the following factors:		
23a	Knowledge acquired during residency / training	……
23b	Knowledge from the literature	……
23c	Knowledge from courses or congresses	……
23d	Knowledge based on clinical impression and experience	……

		Very satisfied	Fairly satisfied	Neutral	Fairly unsatisfied	Very unsatisfied
24	Are you satisfied with the results of the management of CLBP patients in your practice?	**1**	**2**	**3**	**4**	**5**

25a	Are there protocols or guidelines in your clinic as to what CLBP patients can be considered for lumbar fusion?	**1**	Yes, please continue with question 25b
		2	No, please continue with question 25c

		Always	Frequently	Sometimes	Seldom	Never
25b	If yes, do you adhere to these guidelines for every CLBP patient in your practice?	**1**	**2**	**3**	**4**	**5**

		Fully agree	Partially agree	Neutral	Partially disagree	Fully disagree
25c	If no, do you think there should be guidelines for the management of CLBP patients?	**1**	**2**	**3**	**4**	**5**

Research Checklist: + = completed, NA = not applicable

Spinal fusion for chronic low back pain: No consensus in clinical decision making.
Results of a nationwide survey among spine surgeons

The STROBE statement for cross-sectional studies was used as this was considered to be the most appropriate checklist for the present survey among spine surgeons.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
+		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
+ Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
+ Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
+ Study design	4	Present key elements of study design early in the paper
+ Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
+ Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants
+ Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
+ Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
+ Bias	9	Describe any efforts to address potential sources of bias
+ Study size	10	Explain how the study size was arrived at
+ Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
+ Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
+ Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
+ Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders

		(b) Indicate number of participants with missing data for each variable of interest
+ Outcome data	15*	Report numbers of outcome events or summary measures
NA Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
+ Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
+ Key results	18	Summarise key results with reference to study objectives
+ Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
+ Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
+ Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
NA Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Clinical decision making in spinal fusion for chronic low back pain.
Results of a nationwide survey among spine surgeons

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Clinical decision making in spinal fusion for chronic low back pain

Results of a nationwide survey among spine surgeons

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Article summary

Article focus

- What is the level of professional consensus among spine surgeons regarding spinal fusion surgery for chronic low back pain?
- How are tests for patient selection appreciated and to what extent are they used in clinical practice?
- Are prognostic patient factors incorporated in the process of surgical decision making for chronic low back pain?

Key messages

- In clinical practice there is no professional consensus on surgical treatment strategy for chronic low back pain.
- Prognostic patient factors as well as tests for patient selection are not consistently used in clinical decision making for spinal fusion.
- Because of a lack of consensus on spinal fusion strategy for chronic low back pain in clinical practice, no guidelines for proper patient counselling can be installed at present.

Strengths and limitations

A survey among physicians provides valuable insight in the actual decision making process in clinical practice. Understanding contributory factors in treatment strategy may help in the creation of consensus guidelines.

The introduction of an interviewer bias could be avoided by the use of a neutral intermediary instead of direct questions from peers in spine surgery.

This study focussed on surgeon members of the Dutch Spine Society whose practice may not reflect that of all surgeons performing spinal fusion for chronic low back pain. Moreover, no information on conservative treatment options was acquired.

To define consensus we chose for uniformity of opinion of at least 70%, which we considered to be sufficient for implementation in guidelines. Such a cut-off level remains arbitrary.

Structured abstract

Objectives: To assess the use of prognostic patient factors and predictive tests in clinical decision making for spinal fusion in patients with chronic low back pain.

Design and setting: Nationwide survey among spine surgeons in the Netherlands.

Participants: Surgeon members of the Dutch Spine Society were questioned on their surgical treatment strategy for chronic low back pain.

Primary and secondary outcome measures: The surgeons' opinion on the use of prognostic patient factors and predictive tests for patient selection were addressed on Likert scales, and the degree of uniformity was assessed. In addition, the influence of surgeon specific factors, such as clinical experience and training, on decision making was determined.

Results: The comments from 62 surgeons (70% response rate) were analysed. Forty-four surgeons (71%) had extensive clinical experience. There was a statistically significant lack of uniformity of opinion in 7 of the 11 items on prognostic factors and 8 of the 11 items on predictive tests, respectively. Imaging was valued much higher than predictive tests, psychological screening, or patient preferences (All $p<0.01$). Apart from the use of discography and long multi-segment fusions, differences in training or clinical experience did not appear to be of significant influence on treatment strategy.

Conclusions: The present survey showed a lack of consensus among spine surgeons on the appreciation and use of predictive tests. Prognostic patient factors were not consistently incorporated in their treatment strategy either. Clinical decision making for spinal fusion to treat chronic low back pain does not have a uniform evidence base in practice. Future research should focus on identifying subgroups of patients for whom spinal fusion is an effective treatment, as only a reliable prediction of surgical outcome, combined with the implementation of individual patient factors, may enable the instalment of consensus guidelines for surgical decision making in patients with chronic low back pain.

Data sharing statement: All data can be found on doi:10.5061/dryad.7p65c8p4.

Introduction

Chronic low back pain has become one of the main causes of disability in the industrialised world with reported life-time prevalences of up to 85%[1]. In the Netherlands, a small Western European country (16.5 million inhabitants) with a relatively high rate of spine surgery[2], the annual costs of back pain were estimated at 4.4 billion euros, which are mainly employment-related costs (lost productivity due to work absenteeism)[3].

Spinal fusion of a painful or degenerative segment can be beneficial to some patients, but it remains a controversial treatment[4,5]. In the first Cochrane review in 1999, no evidence on the effectiveness of fusion for lumbar degenerative disc disease or low back pain was found as compared to natural history, placebo or conservative treatment[6]. In the updated Cochrane review in 2005[7], two randomized controlled trials (RCT) were included. First, a Swedish trial reported a better outcome of patients treated with spinal fusion compared to patients who received standard conservative care[8], although at longer follow-up this beneficial effect attenuated[9]. Next, a Norwegian RCT that compared fusion surgery to cognitive behavioural based exercise therapy[10] showed similar results for both treatment modalities at 1 year follow-up. Similarly, in the more recent British spine stabilization trial, no clear evidence was found that spinal fusion was more beneficial than an intensive rehabilitation program at 2 years follow-up[11]. Moreover, fusion had a much higher complication rate in this trial and appeared to be less cost-effective than intensive rehabilitation[12,13].

Proper patient selection may improve the outcome of fusion for which several prognostic factors and predictive tests have been reported[4,14-19]. However, epidemiological research reveals large variation in fusion rates between countries and even between different regions within the same country[20,21], suggesting a poor level of professional consensus. Understanding contributory factors in treatment strategy of surgeons, may clarify some of these observed variations and help create consensus guidelines for clinical decision making.

Therefore, we conducted a national survey among spine surgeons in the Netherlands with the aim to assess the surgeons' opinion on prognostic patient factors known from the literature, as well as the use of predictive tests for spinal fusion in clinical practice. In addition, the degree of uniformity in decision making was determined.

Materials and Methods

A 25-question survey (see Appendix) was sent by mail to all surgeon members of the Dutch Spine Society, by Memic, a Center for Data and Information Management, University of Maastricht, the Netherlands (www.memic.unimaas.nl). In an accompanying letter the background rationale for the enquiry, as well as the voluntary and confidential nature was stressed and the surgeons were reassured that individual comments would remain anonymous.

The questionnaire concerned the selection for spinal fusion of patients with low back pain caused by degenerative lumbar disc disease without signs of neurological deficit, spinal stenosis, deformity or spondylolisthesis and in the absence of trauma, tumor or infections. This group was further referred to as chronic low back pain patients. For clarity the questionnaire had first been evaluated and revised by a clinical researcher and two orthopaedic surgeons. Most questions could be answered according to a 5-point Likert scale. Surgeon specific factors (e.g., discipline, clinical experience), the influence of patient factors (prognostic factors as reported in literature), and the use of tests for patient selection (e.g., provocative discography), were addressed. The respondents were specifically asked to rely on their own individual opinion and management in practice.

Those who had not responded received a second call by mail after two months, and final inclusion was set another two months later. Data were entered into Excel™ (Microsoft, Corp., Redmond, WA) and all inconsistencies were resolved. Unanswered questions were coded as missing. Descriptive statistics was used in which all frequencies were based on the number of valid responders.

For analysis the answers on the 5-point Likert scale were merged into one intermediate option (“neutral”) and 2 opposite categories (“always/almost always” versus “never/almost never” and “fully/globally agree” versus “globally/fully disagree”). The data were processed with Statistical Package for the Social Sciences software (SPSS, Inc., Chicago, IL). Pearson’s chi-square test was used to evaluate whether surgeon specific factors were associated with clinical decision making. Uniformity of opinion was defined to be present if 70% or more of the respondents answered similarly. In other words, there was no consensus if the proportion of the largest category was statistically significantly lower than 70% (Pearson’s chi-square test). Differences in mean values rating the impact of factors on decision making,

were tested by Independent t-test for equality of means. The level of significance was set at $p<0.05$.

Results

Nine of the 150 surveyed surgeons (89 orthopaedic surgeons and 61 neurosurgeons) had ended their professional career and 9 respondents stated not to perform spinal surgery anymore. Of the remaining 132 active spine surgeons, 93 (70%) completed and returned the questionnaire. Thirty-one of the 93 respondents (33%) declared not to perform spinal fusion for low back pain and were excluded from further analysis. The characteristics of the final group of 62 respondents are listed in Table 3. The level of experience for neurosurgeons and orthopaedic surgeons was equal: 11 of 16 (69%) versus 33 of 46 (72%) worked ten years or more in clinical practice, respectively.

Prognostic factors

The respondents' comments on prognostic factors are listed in Table 4. For 7 of the 11 items there was no consensus (significantly less than 70% uniformity of opinion). More than 70% of the respondents would fuse patients over 60 years old for back pain. Years of clinical experience or specialty did not appear to be of influence (p=0.504, and p=0.690, respectively).

Eight of 18 academic surgeons and 32 of 43 spine surgeons working in general hospitals operated on patients below 30 for back pain (p=0.025).

Fourteen of 46 orthopaedic surgeons fused patients below 20 for back pain, versus only 1 of 15 neurosurgeons (p=0.063). Eighteen orthopaedic surgeons performed fusion of 3 or more levels for low back pain, whereas no neurosurgeon did (p=0.003).

Tests for patient selection

The surgeons' appreciation and use of predictive tests are listed in Tables 5a and 5b, respectively. Apart from MRI, there was no uniformity regarding the value of these tests for clinical decision making.

Mainly orthopaedic surgeons (21 of 46, versus 2 of 16 neurosurgeons, p=0.025) considered provocative discography to be a valid predictor of fusion. Spine surgeons working in general hospitals (20 of 43), appeared to believe more in the test than academic surgeons did (3 of 18, p=0.028). There was no relation with clinical experience (p=0.406). Apart from the use of discography, differences in discipline or clinical experience did not appear to be of significant influence on treatment strategy.

In the evaluation of chronic low back pain no other predictive tests than those mentioned in Tables 5a and 5b were used on a regular basis.

Individual decision making in clinical practice

Table 1 and figure 1 shows the importance of predictive tests and prognostic factors for clinical decision making as rated on a scale from 0 to 10. Patient history and imaging were valued significantly higher than predictive tests, psychological screening or patient preferences (all respective comparisons: $p<0.01$, Independent t-test).

The impact of surgeon specific factors on treatment strategy is listed in table 2 and figure 2. Experience was rated highest (mean ± sd, 8.0 ± 1.7), as compared to findings from literature (7.7 ± 1.1, $p=0.26$), scientific courses (7.3 ± 1.4, $p=0.01$), and training (6.8 ± 2.8, $p<0.01$).

Twenty-seven (45%) surgeons responded to have a protocol for decision making to which they frequently or always adhered. Of those 35 respondents who did not have such a protocol, 23 (68%) replied that there should be guidelines. In other words, 50 respondents (83%) felt that clinical guidelines in the management of CLBP patients are prerequisite.

Table 1 The importance of listed factors in clinical decision making (presented as mean ± sd) as rated by the respondents on a scale from 0 (no importance) to 10 (maximal importance). Abbreviations: MRI = magnetic resonance imaging, TETF = temporary external transpedicular fixation

	Mean ± sd
History	9.06 ± 1.11
MRI	8.69 ± 1.24
Plain radiographs	8.11 ± 2.01
Physical examination	7.53 ± 2.15
Discography	5.34 ± 3.09
Pantaloon cast	4.95 ± 2.99
Patient's preference	4.75 ± 2.25
Psychological screening	4.70 ± 2.42
Facet joint block	4.06 ± 2.46
Bone scintigraphy	3.80 ± 2.59
TETF	1.96 ± 2.59

Table 2

Table for figure 2 Factors that influence clinical decision making for chronic low back pain (presented as mean ± sd), as rated by respondents on a scale from 0 (no influence) to 10 (maximal influence)

	Mean ± sd
Residency/training	6.76 ± 2.80
Literature	7.72 ± 1.11
Course/congress	7.31 ± 1.37
Clinical experience	8.02 ± 1.72

Discussion

This study presents the results of the first nationwide survey among spine surgeons regarding clinical decision making for spinal fusion in patients with chronic low back pain. The response rate was adequate (70%) and the majority of the respondents (71%) had extensive clinical experience in spinal surgery. A considerable heterogeneity in the use and appreciation of predictive tests was observed. Prognostic patient factors were not consistently incorporated in clinical decision making.

Strengths and weaknesses

This survey focused on surgeon members of the Dutch Spine Society whose practice may not reflect that of all surgeons performing spinal fusion for low back pain. This may have produced a selection bias. It is reasonable, however, to expect that surgeons with a special interest in the spine are exactly those to be most aware of guidelines and research findings in the field.

To define consensus we chose for uniformity of opinion of 70% or more of the respondents. We felt that this level of agreement should be sufficient for implementation in guidelines. Such a cut-off level remains, of course, arbitrary and debatable.

The introduction of an interviewer bias could be avoided by employing Memic, Center for Data and Information Management, as a neutral intermediary. In this way, surgeons could feel free to answer what they personally felt or practiced, as opposed to what they thought would be considered “correct”.

For statistical analysis the 5-point Likert scale responses were merged into 3 categories, which may have simplified the respondents’ opinion on the management of low back pain in practice.

Comparison with related research

According to literature, older age is an acknowledged predictor of poor outcome[14]. Nevertheless, almost three quarters (73%) of the surgeons fused patients above 60 for low back pain.

In literature, 2 or 3-level fusions have proven higher rates of pseudarthrosis with lower patient satisfaction as compared to single level fusions[5,14]. Over 30% of the surgeons would consider fusion of 3 levels or more.

Although the literature says that fusion surgery is not recommended unless 2 years of conservative treatment have failed[22], 63% of the surgeons felt that less than 1 year of conservative therapy is enough to consider fusion.

In literature, obesity is an independent risk factor for low back pain, and surgery in these patients is significantly associated with major complications, such as thrombo-embolism and infection[19]. Nevertheless, 53% of the surgeons would operate for chronic low back pain on obese patients and 24% on the morbid obese. Less than half of the surgeons (47%) consistently referred overweight patients to a dietician.

In literature, smoking is known to be an independent risk factor for low back pain[15], and associated with worse results of spinal fusion[12]. Among surgeons, there was no consensus regarding smoking: About 41% would fuse heavy smokers, whereas 48% would not operate smokers for back pain.

According to literature, psychologically stressful work is associated with low back pain and disability[17], and it has been reported that psychological distress, depressive mood and somatisation lead to an increased risk of chronicity[18]. In addition, presurgical depression is associated with worse patient outcome after lumbar fusion[14]. In contrast, only 16% of the surgeons referred patients routinely for psychological screening and 39% never referred for this purpose at all.

There is strong evidence in literature that clinical interventions are not effective in returning patients back to work once they have been off work for a longer time[22]. About half of the surgeons agreed that the work status of patients with low back pain affects outcome considerably and 69% acknowledged that litigation or workers' compensation are of great influence on decision making, as they have been associated with persisting pain and disability[17].

Two-thirds (66%) of the respondents considered findings on plain radiographs and MRI-scan alone to be insufficient for surgical decision making (Table 3a). This is in accordance with the literature indicating that degenerative or black discs on MRI do not appear to have a strong clinical relevance[23,24] and that there is no correlation between radiographic signs of degeneration and clinical outcome[25].

Opinion differed about trial immobilization with a pantaloon cast: 40% of the respondents agreed that it is a valuable test and 36% disagreed. This resembles

conflicting reports from the literature claiming that the test is not predictive of fusion outcome[26] or that only in highly selected patient groups the pantaloon cast test may be of value[27].

According to literature, provocative discography is a controversial test, which is highly variable in chronic pain patients and can also be positive in pain-free individuals[28]. Its value in predicting the outcome of fusion for low back pain is debated [16,29], which was reflected in the completely contradictory surgeons' opinions. Trial immobilization with a temporary external fixator is known for its high complication rate[30] and because of ambiguous results, its use is not recommended[31]. In the present survey, external fixation was not frequently used (94% never used it) and only 13% of the surgeons believed in its predictive value.

In literature, lumbar facet injections have been reported not to be predictive of either arthrodesis or nonsurgical treatment of back pain[32]. Accordingly, only 8% of the surgeons used facet joint blocks on a regular basis as a predictor of spinal fusion.

Clinical relevance and implications for clinicians and policymakers

The lack of consensus among spine surgeons as found in the present survey could not be explained by differences in training or clinical experience. Apart from the use of discography and long multilevel fusions, the surgeons' discipline and years in practice did not appear to be of significant influence on treatment strategy. More likely, the observed heterogeneity of opinion reflects the absence of consistent high quality evidence for the validity of prognostic factors and predictive tests[33]. As there is no generally acknowledged superior approach for low back pain, substantial variations that exist between practices are caused by clinical uncertainty as to what constitutes the best of care.

In a survey among expert spine surgeons, bad patient selection and disproportionate preoperative expectations were considered to be the major factors for poor outcome in spinal surgery[34]. At present, consistent evidence on tests or tools that reliably predict the outcome of fusion is lacking[35]. Moreover, to provide a reliable estimation of the effectiveness of surgery, preferences of the individual patient, as well as psychological and social factors that may affect outcome, should be assessed[36]. To achieve realistic patient expectations of surgery, good patient counselling should be evidence based, i.e., determined by the best available clinical evidence from systematic research[37], combined with the individual surgeon's expertise and

expectation of treatment success[38]. As the present survey shows, prognostic factors are not consistently incorporated at all in the surgical decision making process. Lack of consensus among surgeons hampers the implementation of clinical guidelines, which are needed for proper patient counselling.

Future research should thus focus on identifying a subgroup of patients for whom spinal fusion is a predictable and effective treatment. If the results of fusion could be improved by better patient selection, there could be a role for spinal fusion as the treatment of choice for this particular subgroup of patients. A reliable prediction of surgical outcome, combined with the implementation of individual patient factors, would enable the instalment of clinical guidelines for surgical decision making. Such guidelines are needed, not only for patient counselling, but also for communication with insurers, policymakers and other health care providers who are involved in the management of chronic low back pain.

Conclusion

The present survey consistently showed a lack of consensus among spine surgeons in surgical decision making. Despite high levels of training and continuous medical education, patient selection for fusion surgery in the treatment of chronic low back pain does not have a uniform evidence base in clinical practice.

Contributions of authors

Paul Willems:	Conception and design of the study
	Acquisition, analysis and interpretation of data
	Drafting the article
	Approval of the final version to be published
Rob de Bie:	Design of the study
	Acquisition and analysis of data
	Revising the article
	Approval of the final version to be published
Cumhur Öner:	Design of the study
	Analysis and interpretation of data
	Revising the article
	Approval of the final version to be published
René Castelein:	Design of the study
	Analysis and interpretation of data
	Revising the article
	Approval of the final version to be published
Marinus de Kleuver:	Conception and design of the study
	Analysis and interpretation of data
	Revising the article
	Approval of the final version to be published

Declarations

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Table 3 Characteristics of the 62 respondents

	Orthopaedic surgeons (n)	Neurosurgeons (n)	All respondents (n)
No. of respondents	46	16	62
Age			
< 50 years	22	10	32
≥ 50 years	24	6	30
Clinical experience			
< 10 years	13	5	18
≥ 10 years	33	11	44
Type of hospital			
University/specialized	13	5	18
General	33	11	44
No. of fusions for CLBP/year			
1-10	24	9	33
10-25	9	6	15
25-50	7	1	8
≥ 50	6	0	6

Abbreviation: CLBP = chronic low back pain; n = number

Table 4 Respondents' opinion to what extent patient-specific prognostic factors influence their clinical decision making in the treatment of CLBP. The numbers listed are percentages of valid responses

Maximum number of levels for fusion	1 level	2 levels	3 or more levels	p-value*
	18 (30.5)	**23 (39.0)**	**18 (30.5)**	**p<0.001**
Minimum age patient	Under 20 yrs	20 to 30 yrs	30 yrs or more	
	15 (24.6)	**25 (41.0)**	**21 (34.4)**	**p<0.001**
Maximum age patient	40 to 50 yrs	50 to 60 yrs	60 yrs or more	
	5 (8.1)	**12 (19.4)**	**45 (72.5)**	**NS**
Minimal length conservative therapy	Less than 6 mo	6 mo to 1 yr	1 yr or more	
	3 (4.8)	**36 (58.1)**	**23 (37.1)**	**NS**
Maximum Body Mass Index (BMI)	Under 31	31 to 37	37 or more	
	29 (46.8)	**18 (29.0)**	**15 (24.2)**	**p<0.001**
Maximum number of cigarettes / day	0	1 to 20	20 or more	
	29 (47.5)	**7 (11.4)**	**25 (40.9)**	**p<0.001**
Referral overweight patients to dietician	Always	Sometimes	Never	
	29 (46.8)	**20 (32.3)**	**13 (21.0)**	**p<0.001**
Psychological screening referral	Always	Sometimes	Never	
	10 (16.2)	**28 (45.2)**	**24 (38.7)**	**p<0.001**
Different criteria for primary DDD versus prior spine surgery	Agree	Neutral	Disagree	
	44 (71.0)	**8 (12.9)**	**10 (16.1)**	**NS**
Work status affects outcome	Agree	Neutral	Disagree	
	29 (46.7)	**17 (27.4)**	**16 (25.9)**	**p<0.001**

Litigation procedures affect outcome	Agree	Neutral	Disagree	
	43 (69.3)	**9 (14.5)**	**10 (16.2)**	**NS**

Abbreviation: DDD = degenerative disc disease, NS = not significant.

*Chi-square test: p<0.05 means significantly less than 70% consensus, NS implies uniformity.

Table 5a Respondents' opinion on predictive tests for clinical decision making. The numbers listed are valid responses and respective percentages

Predictive test	Agree (%)	Neutral (%)	Disagree (%)	p-value*
MRI sufficient for decision making	10 (16.1)	11 (17.7)	41 (66.1)	NS
Cast immobilization valuable test	25 (40.3)	15 (24.2)	22 (35.5)	<0.001
Cast immobilization too unpleasant	11 (17.7)	16 (25.8)	35 (56.5)	0.028
PD proven valuable test	23 (37.7)	16 (26.2)	22 (36.0)	<0.001
PD too many complications	3 (4.9)	14 (23.0)	44 (72.1)	NS
TETF valuable test	8 (13.4)	33 (55.0)	19 (31.6)	0.011
TETF too many complications	20 (32.7)	31 (50.8)	10 (16.4)	0.001

Abbreviations: MRI = magnetic resonance imaging, PD = provocative discography, TETF = temporary external transpedicular fixation, NS = not significant.

*Chi-square test: p<0.05 means significantly less than 70% consensus, NS implies uniformity.

Table 5b The use of predictive tests by the surgeons in clinical practice. The numbers listed are valid responses and their respective percentages

Use of test	Always (%)	Sometimes (%)	Never (%)	p-value*
Facet joint blocks	5 (8.1)	32 (51.6)	25 (40.3)	0.002
Cast immobilization	20 (32.8)	23 (37.7)	18 (29.6)	<0.001
PD	25 (42.4)	10 (16.9)	24 (40.7)	<0.001
TETF	0 (0.0)	3 (4.9)	58 (95.1)	NS

Abbreviations : PD = provocative discography, TETF = temporary external transpedicular fixation, NS = not significant.

*Chi-square test: $p<0.05$ means significantly less than 70% consensus, NS implies uniformity.

Appendix

Questionnaire on decision making for lumbar spinal fusion in chronic low back pain patients

1	What is your discipline?	**1**	Neurosurgery
		2	Orthopaedic surgery
		3	Other, ……
2	What is your age?	**1**	Under 30 years
		2	30 to 40 years
		3	40 to 50 years
		4	50 to 60 years
		5	60 years or older
3	Since when do you perform spinal surgery?	**1**	Less than 1 year
		2	1 to 5 years
		3	5 to 10 years
		4	10 to 15 years
		5	15 years or more
4	In what kind of hospital do you work? *(more than one answer possible)*	**1**	University hospital
		2	General teaching hospital
		3	General nonteaching hospital
		4	Specialized hospital
		5	Other, ……

The next questions concern the indication for lumbar spinal fusion (or lumbar total disc replacement if appropriate) in patients with low back pain caused by degenerative lumbar disc disease without signs of neurological deficit, spinal stenosis, deformity or spondylolisthesis and in the absence of trauma, tumor, infections or other consuming illnesses, further to be referred to as chronic low back pain (CLBP) patients

5	How many lumbar fusions do you perform each year in CLBP patients?	**1**	0
		2	1 to 10
		3	10 to 25
		4	25 to 50
		5	50 or more
6	How many total disc replacements do you perform each year in CLBP patients?	**1**	0
		2	1 to 10
		3	10 to 25
		4	25 to 50
		5	50 or more
7	What is for you the maximum number of levels to be fused in CLBP patients?	**1**	1
		2	2
		3	3
		4	4 or more

		5	No maximum
8a	What is for you the absolute minimum age of a CLBP patient to be considered for lumbar fusion?	**1** **2** **3** **4** **5**	Under 20 years 20 to 30 years 30 to 40 years 40 years or more No minimum age
8b	What would be for you the absolute maximum age of a CLBP patient to be considered for lumbar fusion?	**1** **2** **3** **4** **5**	Under 40 years 40 to 50 years 50 to 60 years 60 years or older No maximum age
9	How long should a CLBP patient at least have followed conservative therapy in order to be considered for lumbar fusion?	**1** **2** **3** **4** **5**	0 to 6 months 6 months to 1 year 1 to 2 years 2 years or longer No minimum
10a	What would be for you the maximum weight of a 1.80 meter long male CLBP patient in order to be considered for lumbar fusion?	**1** **2** **3** **4** **5**	Less than 80 kg 80 to 100 kg 100 to 120 kg 120 kg or more No maximum weight
10b	Do you send overweight CLBP patients to a dietician before considering lumbar fusion?	**1** **2** **3** **4** **5**	Always Frequently Sometimes Seldom Never
11	What is for you the maximum number of cigarettes a CLBP patient is allowed to smoke in order to be considered for lumbar fusion?	**1** **2** **3** **4** **5**	0 cigarettes per day 1 to 10 cigarettes per day 10 to 20 cigarettes per day 20 or more cigarettes per day No maximum
12	Do you send CLBP patients for psychological screening before considering lumbar fusion?	**1** **2** **3** **4** **5**	Always Frequently Sometimes Seldom Never

You are requested to indicate whether you agree or not with the following statements.

		Fully agree	Partially agree	Neutral	Partially disagree	Fully disagree
13	The preoperative selection criteria for CLBP patients who had spine surgery before are substantially different from those for CLBP patients without prior spine surgery.	**1**	**2**	**3**	**4**	**5**
14	The work status (Full or partial disability, long term sick leave) of a CLBP patient is of great influence on your decision to perform lumbar fusion.	**1**	**2**	**3**	**4**	**5**
15	Involvement in litigation or workers compensation processes is of great influence on your decision making.	**1**	**2**	**3**	**4**	**5**
16	Plain radiographs and MRI-findings in CLBP patients are sufficient for your decision to perform lumbar fusion.	**1**	**2**	**3**	**4**	**5**

The next statements and questions concern clinical tests that may be helpful in decision making for lumbar fusion in CLBP patients.

17a	Trial immobilization in a plaster jacket or pantaloon cast is a proven valuable test for decision making in CLBP patients.	**1**	**2**	**3**	**4**	**5**
		Always	Frequently	Sometimes	Seldom	Never
17b	Do you use this trial immobilization in a cast in CLBP patients?	**1**	**2**	**3**	**4**	**5**
		Fully agree	Partially agree	Neutral	Partially disagree	Fully disagree
17c	Trial immobilization in a cast is too unpleasant for the patient to be executed.	**1**	**2**	**3**	**4**	**5**

18a	Provocative discography is a proven valuable test for decision making in CLBP patients.	Fully agree **1**	Partially agree **2**	Neutral **3**	Partially disagree **4**	Fully disagree **5**
18b	Are CLBP patients in your practice selected for fusion by provocative discography?	Always **1**	Frequently **2**	Sometimes **3**	seldom **4**	Never **5**
18c	Provocative discography has too many complications to be executed.	Fully agree **1**	Partially agree **2**	Neutral **3**	Partially disagree **4**	Fully disagree **5**
19a	Temporary external transpedicular fixation (TETF) of one or more segments is a proven valuable for decision making in CLBP patients.	Fully agree **1**	Partially agree **2**	Neutral **3**	Partially disagree **4**	Fully disagree **5**
19b	Do you use TETF as a tool for decision making in CLBP patients?	Always **1**	Frequently **2**	Sometimes **3**	Seldom **4**	Never **5**
19c	TETF has too many complications to be executed in CLBP patients.	Fully agree **1**	Partially agree **2**	Neutral **3**	Partially disagree **4**	Fully disagree **5**
20	Are CLBP patients in your practice selected for fusion by facet joint blocks?	Always **1**	Frequently **2**	Sometimes **3**	Seldom **4**	Never **5**

21	Do you use other tests as a selective tool for lumbar fusion in CLBP patients?	**1**	No
		2	Yes, …… …… ……

Could you rate on a scale ranging from 0 (no importance) to 10 (maximum importance) how important you consider each of the following items as a selective tool for lumbar fusion in CLBP patients		**0 to 10**
22a	Plain radiographs	……
22b	MRI-scan	……
22c	Bone scintigraphy	……
22d	History	……
22e	Physical examination	……
22f	Psychological screening	……
22g	Patient's preferences	……
22h	Facet joint blocks	……
22i	Trial immobilization by pantaloon cast	……
22j	Lumbar provocative discography	……
22k	Temporary external transpedicular fixation	……

Could you rate on a scale ranging from 0 (no influence) to 10 (maximal influence) to what extent your policy regarding the operative management of CLBP patients has been influenced by the following factors:		**0 to 10**
23a	Knowledge acquired during residency / training	……
23b	Knowledge from the literature	……
23c	Knowledge from courses or congresses	……
23d	Knowledge based on clinical impression and experience	……

		Very satisfied	Fairly satisfied	Neutral	Fairly unsatisfied	Very unsatisfied
24	Are you satisfied with the results of the management of CLBP patients in your practice?	**1**	**2**	**3**	**4**	**5**

25a	Are there protocols or guidelines in your clinic as to what CLBP patients can be considered for lumbar fusion?	**1**	Yes, please continue with question 25b
		2	No, please continue with question 25c

		Always	Frequently	Sometimes	Seldom	Never
25b	If yes, do you adhere to these guidelines for every CLBP patient in your practice?	**1**	**2**	**3**	**4**	**5**
		Fully agree	Partially agree	Neutral	Partially disagree	Fully disagree
25c	If no, do you think there should be guidelines for the management of CLBP patients?	**1**	**2**	**3**	**4**	**5**

Research Checklist: + = completed, NA = not applicable

Spinal fusion for chronic low back pain: No consensus in clinical decision making.

Results of a nationwide survey among spine surgeons

The STROBE statement for cross-sectional studies was used as this was considered to be the most appropriate checklist for the present survey among spine surgeons.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
+		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
+ Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
+ Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
+ Study design	4	Present key elements of study design early in the paper
+ Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
+ Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants
+ Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
+ Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
+ Bias	9	Describe any efforts to address potential sources of bias
+ Study size	10	Explain how the study size was arrived at
+ Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
+ Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
+ Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
+ Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders

		(b) Indicate number of participants with missing data for each variable of interest
+ Outcome data	15*	Report numbers of outcome events or summary measures
NA Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
+ Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
+ Key results	18	Summarise key results with reference to study objectives
+ Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
+ Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
+ Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
NA Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

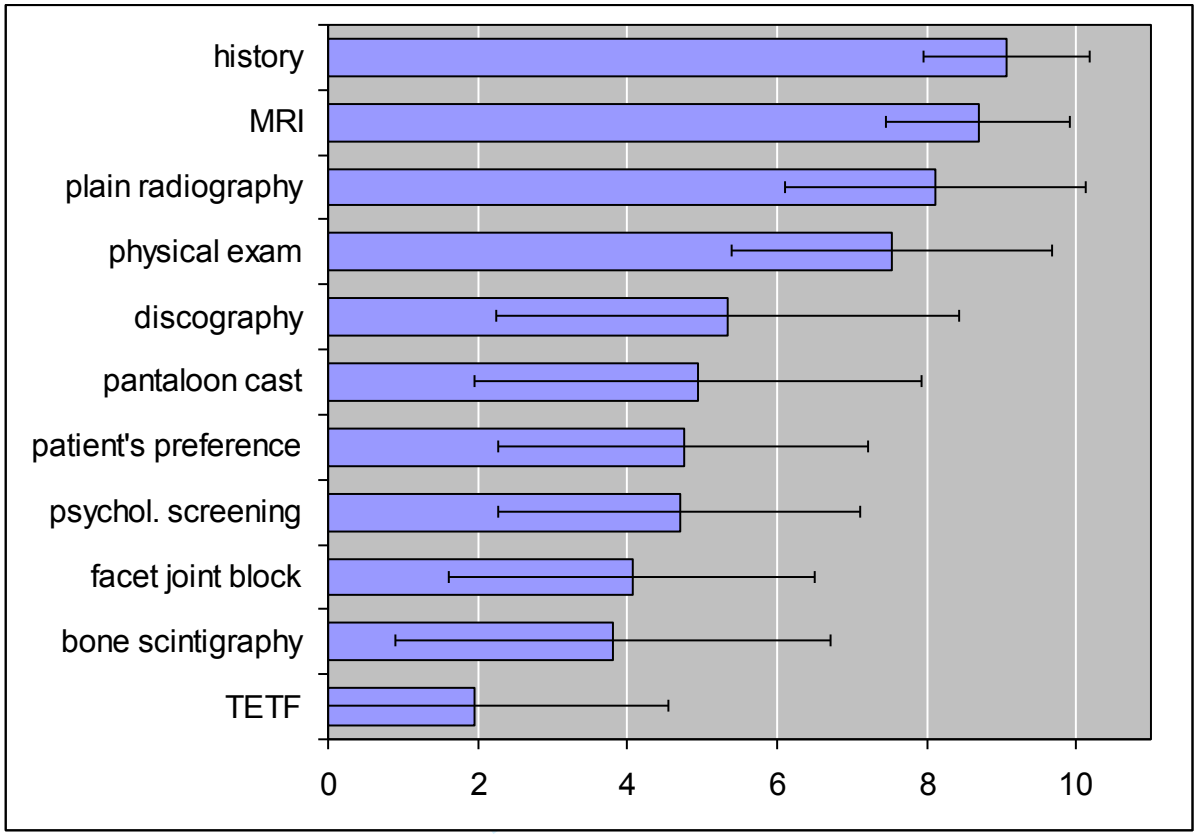

Figure 1 The importance of listed factors in clinical decision making (presented as mean ± sd) as rated by the respondents on a scale from 0 (no importance) to 10 (maximal importance). Abbreviations: MRI = magnetic resonance imaging, TETF = temporary external transpedicular fixation

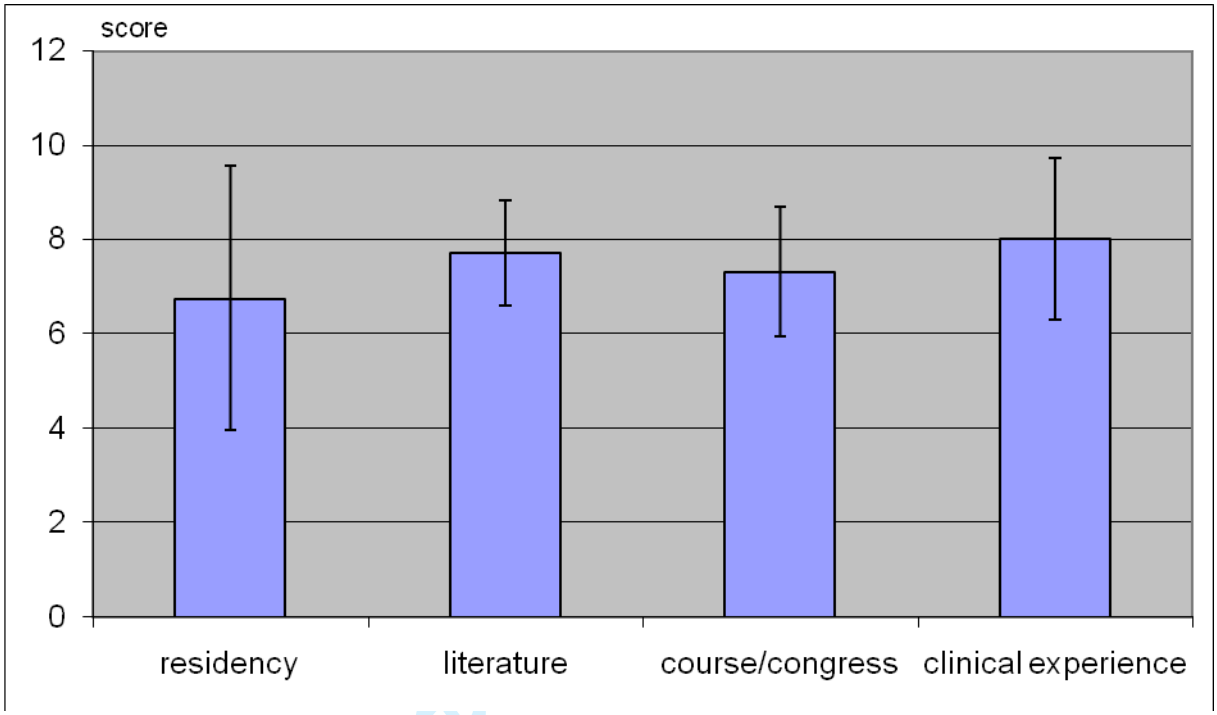

Figure 2 Factors that influence clinical decision making for chronic low back pain (presented as mean ± sd), as rated by respondents on a scale from 0 (no influence) to 10 (maximal influence)