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Lumbar spinal fusion: indications, surgical techniques and post-operative management. a survey among spine surgeons in the Netherlands

Abstract

Study design: Cross sectional study

Objective: Spinal fusion is commonly used for treatment of degenerative disc disorders. However, there is no consensus among spinal surgeons on operative technique, the type of implant being used and postoperative care. With the growing importance of Evidence Based Medicine, the demand for clinical guidelines is increasing. The aim of this study was to provide an overview of the current practice regarding lumbar spinal fusion among spinal surgeons in the Netherlands. The findings of this enquiry may help to create guidelines.

Methods: An online 30-question survey was sent to all members of the DSS (orthopedic surgeons and neurosurgeons), focusing on operative techniques, implants and post-operative care after spinal fusion in patients with symptomatic degenerative conditions of the lumbar spine.

Results: The response rate was 66%. The bilateral PLIF technique with 2 cages was preferred by most surgeons. Neurosurgeons used a PEEK cage more often, whereas orthopedic surgeons preferred a titanium cage. There was no consensus on assessment of outcome of fusion and post-operative care.

Conclusion: There is little consensus among spine surgeons in the Netherlands regarding perioperative management, type of instrumentation and implants, operation technique, and postoperative management in lumbar spinal fusion in patients with symptomatic degenerative disc disorders, which underlines a growing demand for uniform guidelines.

Keywords: Online survey, Lumbar fusion, Disc degeneration, Operative techniques, Post-operative management, Guidelines

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Abbreviations: ALIF, Anterior Lumbar Interbody Fusion; CLBP, Chronic Low Back Pain; DDD, Degenerative Disc Disorders; DSS, Dutch Spine Society; DSSR, Dutch Spine Surgery Registry; SDD, Symptomatic Disc Degeneration; F/E, Flexion/Extension; LBP, Low Back Pain; LMWH, Low Molecular Weight Heparin; NASS, North American Spine Society; Nsaids, Non-Steroidal Anti-Inflammatory Drugs; ODI, Oswestry Disability Index; PCA, Patient Controlled Analgesia; PEEK, Polyetheretherketone; PF/PLF, Posterior/Posterolateral Fusion; PLIF, Posterior Lumbar Interbody Fusion; Proms, Patient Related Outcome Measures; RCT, Randomized Controlled Trial; RMDQ, Roland Morris Disability Questionnaire; SF36, Short Form 36; TLIF, Transforaminal Lumbar Interbody Fusion;VAS, Visual Analogue Scale; VESC, Vertebral Endplate Signal Changes; VTE, Venous Thromboembolism

Introduction

Low back pain (LBP) is a major health problem with life-time prevalence up to 84%.[1] Degenerative disc disorders (DDD) are held responsible.[2] Several surgical and non-surgical treatment options have been developed to reduce pain and improve function, including spinal fusion.[3] However, large variation in clinical outcome has been reported.[4,5] This difference can be partially explained by the lack of consensus for indications for surgery.[5] Moreover, there are several surgical techniques and implant materials for performing spinal fusion.[4,6] Also, post-operative rehabilitation may play an important role in the outcome of surgery, with multidisciplinary cognitive-behavioral interventions as one of the latest developments.[7] Finally, there is no global consensus which clinical and radiographic outcome measures should be used to determine the outcome of surgery.[4]

With the growing importance of Evidence Based Medicine, the demand for clinical guidelines is increasing. Patients, care givers, insurance companies and policymakers have a need for uniform and consistent counseling, for which consensus in clinical practice is essential. In 2014 the Nijmegen decision tool was published.[8] A Delphi approach was used to determine 47 indicators, which help referring a patient with chronic low back pain (CLBP) to the proper caregiver (surgical or non-surgical). It is the first step in reducing costs and improving the outcome of spinal interventions.

Purpose

The aim of this study was to provide an overview of the current surgical practice for degenerative lumbar conditions among spinal surgeons in the Netherlands. Subsequently, the findings of this enquiry will be compared to the updated guidelines for the performance of fusion procedures for degenerative disease of the lumbar spine, published in 2014 by the North American Spine Society (NASS).[9]

Materials and methods

Design

Cross-sectional study

Patient sample and data management: On February 1, 2013, an online 30-question survey (Appendix 1) was sent by e-mail to all

members (orthopedic surgeons and neurosurgeons) of the Dutch Spine Society (DSS). It contained a web link to the online survey, a brief introduction, and background rationale and 3-week timeline for completion of the questionnaire. Also, the confidential and voluntary nature was addressed. Return of the questionnaire was considered as consent to participate. Joomla (Open Source Matters Inc) was used to administer the survey and collect the data.

A reminder email was sent after one month. Final call for participation was made on the annual congress of the DSS on November 8, 2013.

Outcome measures: The questionnaire consisted of 30 multiple choice questions focusing on operative techniques, implant materials and post-operative care after spinal fusion in patients with symptomatic degenerative conditions of the lumbar spine (L1-S1). Also, the criteria for symptomatic disc degeneration (SDD) were addressed, since these play an important role in the indication for surgery. Additionally, the outcome of surgery was assessed. The questionnaire was evaluated and revised by two orthopedic surgeons, two neurosurgeons and a clinical researcher prior to distribution. Participants were asked to rely on their own experience regarding the indications, technique, materials and post-operative care for elective spinal fusion operations.

Data analysis: Data were downloaded and entered into Microsoft Excel (Microsoft Corp., Redmond, Washington, USA). All personally identifiable data were deleted. Unanswered questions were coded as missing. Statistical analyses were performed with Statistical Package for the Social Sciences software (SPSS 22.0, SPSS Inc., Chicago, Illinois, USA). Descriptive statistics were used to describe the main characteristics. Pearson's X2 test was used to evaluate if the answers were significantly different. Significance level was set at $p<0.05$. If the conditions for the Chi-square test were not matched the Fischer's exact test was used.

Results

Participants

The survey was sent to all 158 members of the DSS, comprising 101 orthopedic surgeons and 57 neurosurgeons. 79 of the surveyed surgeons had either ended their surgical practice or did not perform lumbar spinal fusion for degenerative conditions. Of the remaining 79 surgeons, 52 (66%) responded. The characteristics of the final group are listed in Table 1. A majority of the respondents (65%) preferred open surgical approach. The self-reported average duration of surgery was less than 150 minutes in 83% of the respondents. There was no significant difference in the level of clinical experience between the orthopedic surgeons and neurosurgeons (p=0.67). The self-reported average duration of surgery did not differ between orthopedic surgeons and neurosurgeons (p=0.82).

Disc degeneration on imaging

Table 2 lists the aspects related to symptomatic disc degeneration (SDD). Pfirrmann et al.[10] described a T2-weighted MRI grading system for lumbar disc deeneration, which is often used in clinical practice.[10] A majority of respondents (52%) did not use the Pfirrmann scale on MRI (10) as a measure for SDD, but 54% related Modic changes on MRI to SDD. The majority of the respondents (75%) did not relate the vacuum phenomenon on CT or plain radiographs to SDD, and 58% did not use provocative discography to diagnose SDD. 67% of the respondents who performed <25 fusions a year considered loss of disc height as a sign of SDD where as only 39% of the respondents with >25 fusions a year did (p=0.05). There was no relation with clinical experience (p=0.60). There was a significant difference amongst orthopedic surgeons and neurosurgeons interpreting loss of disc height on plain radiographs as a sign of SDD, 69% vs 28% respectively (p=0.01). Also, orthopedic surgeons used the Pfirrmann score significantly more often compared to neurosurgeons, 59% vs 33% respectively (p=0.05).

Table 1 Characteristics

	Orthopedics Surgeons (n)	Neuro Surgeons (n)	Discipline Unknown (n)	All (n)
No. of Respondents				
	32(62%)	18 (34%)	2(4%)	52 (100%)
No. of Fusions/Year				
<25	17(53%)	7(39%)	-	24 (46%)
>25	15(47%)	11(61%)	2	28 (54%)
Years of Experience				21 (40%)
<10	14(44%)	7(39%)	-	21(40%)
>10	17(53%)	11(61%)	1	29(56%)
Unknown	1(3%)		1	2 (4%)
Preferred Technique				6 (12%) 37 (71 %) 8 (15%)
Open	22(69%)	1(67%)	-	34 (65%)
Less Invasive	10(31%)	6(33%)	2	18 (35%)
Average Operation Time				
<90 min	4(13%)	2(11%)	-	6 (12%)
90-150 min	23(72%)	12(67%)	2	37 (71%)
>150 min	4(12%)	4(22%)	-	8 (15%) 2 (4%)
Unknown	1(3%)		-	1 (2%)

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Table 2 Relating Symptomatic disc degeneration to one of the following aspects

	Orthopedics Surgeons (n)	Neuro Surgeons (n)	Discipline Unknown (n)	All (n)	P-Value
Loss of Disc Height on X ray					0.01
Yes	22(69%)	5(28%)	-	27(52%)	
No	10(31%)	13(72%)	2	25(48%)	
Disc Degeneration on MRI (Prifrrmann)					0.05
Grade 1	1(3%)	-	-	1(2%)	
Grade 2	-	-	-		
Grade 3	13(41%)	3(17%)	-	16(31%)	
Grade 4 or 5	5(16%)	3(17%)	-	8(15%)	
No	13(41%)	12(67%)	2	27(52%)	
Modic Changes on T1 MRI					0.96
Yes	18(56%)	10(56%)	-	28(54%)	
No	14(44%)	8(44%)	2	24(46%)	
Vacuum Phenomenon on CT/X ray					0.26
Yes	10(31%)	3(17%)	-	13(26%)	
No	22(69%)	15(83%)	2	39(75%)	
Recognizable Pain upon Provocative Discography					0.36
Yes	15(47%)	6(33%)	1	22(42%)	
No	17(53%)	12(67%)	1	30(58%)	

Indication for surgery

Indications for spinal fusion surgery are listed in figure 1. A minority of respondents (28%) would perform a spinal fusion on patients who presented with DDD causing LBP without radicular pain. A majority of these surgeons (71%) related loss of disc height on plain radiograph to SDD. Moreover, the majority of these surgeons related a Pfirrmann score ≥ grade 3 (64%) and Modic changes on MRI (86%) to SDD. A minority of these surgeons also related a vacuum phenomenon (29%) to SDD. Provocative discography was related to SDD by half of these surgeons (50%). Overall, there were no significant differences between orthopedic surgeons and neurosurgeons in indications for surgery. Spondylolisthesis with radicular pain was considered an indication for surgery by all respondents (Figure 1).

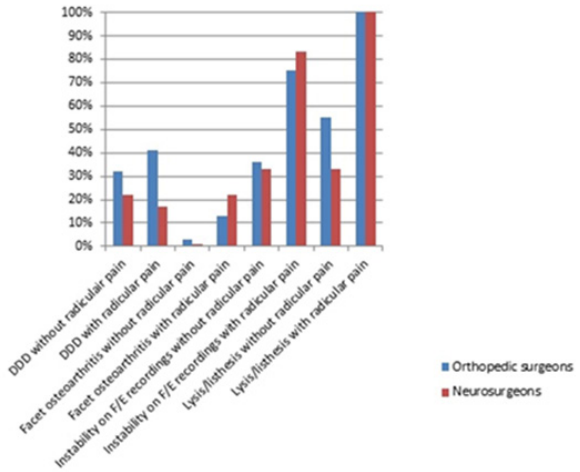

Figure 1 Indications for final fusion.

DDD: Degenerative Disc Diseases; F/E: Flexion/Extension.

Operation techniques

The most commonly used fusion techniques are listed in Figure 2. All respondents used pedicle screw fixation during a lumbar spinal fusion. The bilateral posterior lumbar interbody fusion (PLIF) with 2 interbody cages was the most used additional surgical technique (44%). A majority of respondents did not change their surgical technique in case of spondylolisthesis (73%), symptomatic central stenosis (77%) or foraminal stenosis (79%). Neurosurgeons used the technique with a bilateral PLIF with 2 interbody cages significantly more often than orthopedic surgeons, 67% vs 36% respectively (p=0.04). There was no relation with years of experience and fusion technique (p=0.86). Neurosurgeons reported to remove significantly more of the disc than orthopedic surgeons; 25% of the orthopedic surgeons reported to remove less than 50% of the disc, whereas all neurosurgeons reported to remove more than 50% (p=0.04). Of all the respondents, 67% reported to remove more than half of the disc.

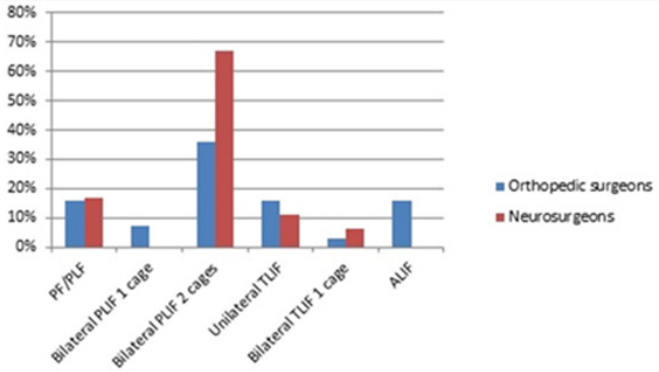

Figure 2 Standard fusion technique.

PF/PLF: Posterior/Posterolateral Fusion; PLIF: Posterior Lumbar Interbody Fusion; TLIF: Transforaminal Lumbar

Interbody Fusion; ALIF: Anterior Lumbar Interbody Fusion

Interbody implants and types of grafts

The implants used for interbody fusion are listed in Figure 3. The most commonly used material was a polyetheretherketone (PEEK) cage (44%). The majority of the respondents (56%) considered

local autologous bone graft to be the best option for cage filling. Neurosurgeons used a PEEK cage significantly more often than orthopedic surgeons did, 78% vs 25%, respectively (p<0.01). Orthopedic surgeons preferred a titanium cage significantly more often compared to neurosurgeons, 34% vs 6%,respectively (p=0.02).

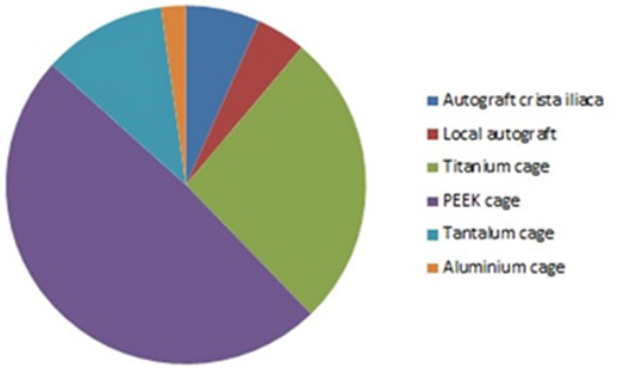

Figure 3 Standard material used for interbody fusion.

PEEK: polyethretherketone

Post-operative care

For postoperative pain treatment 79% of the respondent's prescribed intravenous patient controlled analgesia (PCA) with morphine, 6% PCA-spinal/epidural morphine, 46% non-steroidal anti-inflammatory drugs (NSAIDs), 48% acetaminophen/perfalgan, 15% opioids and 10% used local anesthesia. None of the respondents used gabapentin or pregabalin. Perioperative antibiotics were used for 24 hours by 60% of the respondents, 39% prescribed a single dose of prophylactic antibiotics. 37% of spinal surgeons prescribed anticoagulants (low molecular weight heparin (LMWH)) postoperatively, mainly for 4-6 weeks. A vast majority of the respondents (94%) allowed patients to mobilize within 24hrs after surgery. 64% of spinal surgeons recommended against the use of a lumbar orthosis postoperatively, although all of the surgeons (100%) who reported to prefer a posterior/posterolateral fusion (PF/PLF) procedure recommended the use of a lumbar orthosis postoperatively. Within this group there were no significant differences between orthopedic surgeons and neurosurgeons (p=0.48) or years of experience (p=0.88) Referral to a physical therapist was done on a regular base by the majority of the respondents (61%).

Postoperative assessment

Radiographic assessment of lumbar fusion is listed in Figure 4. The vast majority of surgeons assessed the result of fusion both radiologically and clinically (98%). 53% of surgeons assessed fusion after 1 year, 18% after 6 months and 14% after 3 months. The remaining 15% only evaluated the radiological fusion in case of persistent symptoms. There was no relation with clinical experience or case-load. In total, the most frequently used technique for imaging was plain radiographs (89% of all respondents). CT was used significantly more by neurosurgeons compared to orthopedic surgeons, 84% vs 31% respectively (p<0.01). Plain radiographs were used most by orthopedic surgeons (94%).

In order to measure the clinical outcome, most surgeons (62%) used validated questionnaires/patient related outcome measures (PROMs) (Figure 5).The Visual Analogue Scale (VAS) leg pain (52%) and VAS-back pain (48%) were the most used questionnaires. The Oswestry Disability Index (ODI) was the preferred questionnaire for measuring physical functioning (37% of respondents). There was a relation with clinical experience; surgeons with >10 years of experience used PROMs significantly more frequently than surgeons with <10 years of experience, 72% vs 43% respectively (p=0.04). There was no relation with case load (p=0.12). There were no significant differences between orthopedic surgeons and neurosurgeons (p=0.48).

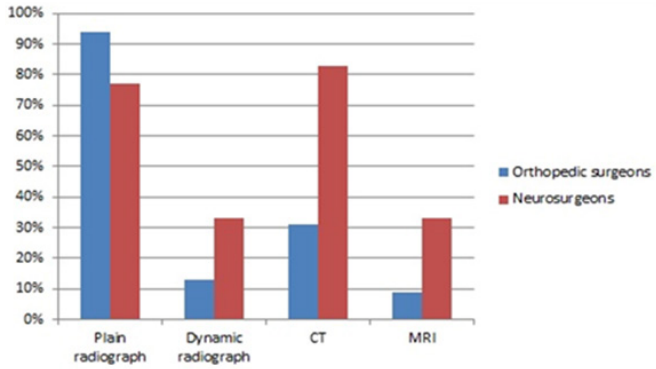

Figure 4 Standard radiographic assessment fusion.

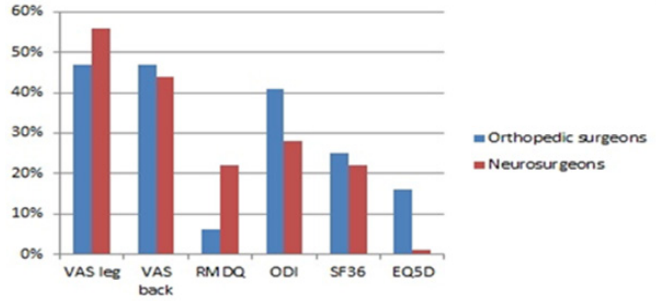

Figure 5 Standard assessment of clinical outcome of spinal fusion by PROMs.

PROMs: Patient Reported Outcome Measures; VAS: Visual Analogue Scale; RMDQ: Rolland Mirris Disability

Questionnaires; ODI: Oswestry Disability Index; SF36: Short Form 36.

Discussion

In literature, the relation between disc degeneration on MRI and low back pain has been controversial. Although abnormal MRI findings in asymptomatic patients have been commonly observed[11] a large study conducted in 2009 demonstrated a significant association between lumbar disc degeneration on MRI and occurrence of low back pain symptoms.[12] Pfirrmann et al.[10] described a validated T2-weighted MRI grading system for lumbar disc degeneration. Still, more than half (52%) of the respondents in our survey did not use this classification. Respondents who would regularly perform a spinal fusion on patients with SDD without radicular pain used the Pfirrmann score more often (64%). In 1988 Modic et al.[13] described several vertebral endplate signal changes (VESC) on MRI in patients with non-specific low back pain.[13] The relationship between VESC, or Modic changes, on MRI and CLBP and disc degeneration has been shown by numerous studies.[14,15] However, a recently published randomized controlled trial (RCT) reported opposite results.[16] Accordingly, about half (54%) of the respondents related Modic changes to SDD. Respondents who would perform a spinal fusion on patients with SDD without radicular pain related Modic changes more often to SDD (86%).

Provocative discography is a controversial test due to unclear diagnostic accuracy, as it does not reliably predict the outcome of fusion.[17] It may also cause degeneration of the disc.[18] Therefore, the NASS does not recommend the use of discography to formulate treatment strategies for patients with low-back pain.[19] Despite this,

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42% of the respondents performed provocative discography and related recognizable pain with leakage of contrast to SDD.

The majority of the respondents (77%) preferred an interbody fusion technique, whereas 16% preferredPF/PLF. Although comparable in clinical outcomes, interbody fusion has been reported to be superior to posterolateral fusion in terms of higher fusion rates and better restoration of lumbar segmental and lordoticangle.[20,21] There are several studies that compared different interbody fusion techniques.[22] However these are all underpowered studies. As reported by the updated guidelines of the NASS, no general recommendation can therefore be given.[23]

Bone grafts alone instead of a cage lead to higher rates of collapse and pseudoarthrosis.[24] Although use of cages for interbody fusion is common practice there is no consensus in literature on which type of cage should be preferred. Few studies have been published comparing different cage materials in lumbar surgery. No differences between PEEK and titanium cages regarding clinical and radiographic outcome were reported.[25] In our survey the opinion was divided; most neurosurgeons preferred a PEEK cage (78%) whereas orthopedic surgeons preferred a titanium cage (34%).

Conflicting results are described concerning postoperative pain management. No difference in overall patient satisfaction with pain management, ambulation and length of stay was found between intravenous PCA and epidural PCA.[26] However, other studies have described better pain management for epidural PCA with less side effects.[27,28] Therefore, a recommendation based on the literature could not be given. The vast majority of respondents in our survey favored intravenous PCA (79%).

NSAIDs have been associated with a higher risk for nonunion in patients undergoing spinal fusion.[29-31] NSAIDs are not superior to continuous subcutaneous and continuous epidural morphine for postoperative pain reduction perioperative.[32] Still, about half (46%) of the respondents used NSAIDs after spinal surgery. Based on the literature we therefore advise against the use of NSAIDs.

In 2013 the NASS published an evidence based clinical guideline for the use of antibiotic prophylaxis in spine surgery.[33] All of the respondents in our survey used prophylactic antibiotics during spinal surgery. There is insufficient evidence in the literature about the effect of single dose antibiotics versus prolonged antibiotic. Therefore no recommendations could be given.

In 2009 the NASS published an evidence based clinical guideline for the use of anti-thrombotic therapies in spine surgery. They recommended that pharmacological prophylaxis may be used postoperatively. However, these therapies should be considered on an individual case-by-case basis, as use may place patients at increased risk of bleeding complications.[34] In our survey, only 37% of the respondents used venous thromboembolism (VTE) prophylaxis after spinal fusion, which were mainly orthopedic surgeons. This difference could be partly explained by their general acquaintance with the use of anticoagulants in joint-replacement surgeries. Based on the recommendations of the NASS, we suggest that VTE prophylaxis should be given perioperative to all spinal fusion patients unless they have a high risk of complications due to comorbidities. The length of prescription remains debatable.

There is insufficient evidence in literature about the use of a postoperative brace after interbody fusion or open vs less invasive procedures.[35] The updated guidelines of the NASS do not recommend the use.[36] In our survey 35% recommended the use postoperative, mainly by surgeons who reported to prefer an open procedure.

Bony fusion can be assessed by several radiographic techniques, including plain and dynamic radiographs, CT, MRI or bone scintigraphy. Plain radiographs are relatively cheap and easy to obtain with low radiation exposure. However, there are limitations: Static plain radiograph is only accurate in determining bony fusion in approximately two-thirds of the cases.[37] CT scanning has a higher accuracy and thus, it has been recommended to use plain radiograph in combination with CT scanning in case of persisting symptoms.[38] This combination is also recommended by the NASS.[39] Half of the respondents in our enquiry used CT scanning. The majority of the respondents (89%) used plain radiographs. 16% of the respondents assessed the radiological fusion only in case of clinical symptoms.

The uses of PROMs are essential for comparing the effectiveness of different treatments.[40] Several validated outcome measures are used, such as the VAS leg and VAS back pain, ODI, Roland Morris Disability Questionnaire (RMDQ) and Short Form 36 (SF36). However, in literature there is no consensus about which questionnaire should be used in standard clinical practice.[4] Due to this it is very difficult to compare the outcome of different surgical techniques, implants and post-operative care. Therefore, the general use of selected questionnaires should be encouraged. Still, a large percentage of the respondents did not use any questionnaires in standard clinical practice (39%). The development of national registries with standard validated PROMs could help to gain more insight in the clinical outcome of patients. The NASS have recommended the use of the ODI and SF36 in their updated guidelines.[40]

Referral to a physical therapist was done on a regular base by the majority of the respondents (61%). However, best clinical practice for physical therapy after a spinal fusion still remains unclear. A systematic review and meta-analysis evaluated the effectiveness of physical therapy following lumbar spinal fusion.[41] The results were inconclusive. Also, timing of rehabilitation remains unclear.[42] A large RCT about the effect of multidisciplinary cognitive-behavioral interventions for patients after spinal fusion was recently started.[43]

Clinical relevance

The community has a need for uniform and consistent counseling, for which consensus in clinical practice is essential. The Nijmegen decision tool and the updated guidelines by the NASS are important steps in this process.[8,9] However, there is no consensus among spinal surgeons in the Netherlands regarding operative technique, type of instrumentation and cage material, postoperative management or radiological and clinical assessment in lumbar spinal fusion in patients with SDD.

Due to this patients are receiving a variety of treatments across the country with accompanying variety of possible long-term outcomes. Patient counseling prior to surgery is an important part of the surgeon's responsibility. Also, preoperative expectations are considered a major factor on the outcome of surgery.[44] Since different surgical strategies result in different costs for surgery and post-operative care, third party-stakeholders such as policy makers and insurance companies ask for transparency and uniform treatment strategy.

In 2014 the Dutch Spine Surgery Registry (DSSR) started, in which surgeons are encouraged to enter their indications, operative strategies, type of materials and post-operative care of spinal fusions. Also, during follow-up patients are asked to fill in several validated PROMs (VAS leg and back pain, ODI, SF36, EQ-5D). This will allow the Dutch spinal community to create an overview of the general practice and monitor the effect of treatment and complications in clinical practice more closely. Together with the continued effort of

the scientific community this may enable the installment of national guidelines for best practice in lumbar spinal care.

Limitations

This survey was conducted among DSS members and thus, the results may not be representative for all spine clinics. However, the vast majority of spine surgeons in the Netherlands that perform instrumented spinal fusion are a member of the DSS.

Conclusion

There is little consensus among spine surgeons in the Netherlands regarding perioperative management, type of instrumentation and cage material, operation technique, and postoperative management in lumbar spinal fusion in patients with symptomatic degenerative disc disorders, causing LBP. In society there is a growing demand for transparent uniform care. Therefore, the spinal community should put maximum effort in creating evidence based consensus guidelines for clinical practice.

Authors contributions

RK contributed to the acquisition, analysis and interpretation of data, drawing of the manuscript and statistical analysis. SvG contributed to conception and design, analysis and interpretation of data, revision and administrative support. PW contributed to analysis and interpretation of data and revision. MA contributed to revision, WP and FC contributed to conception and design and supervision.

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None.

Conflicts of interest

None.

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