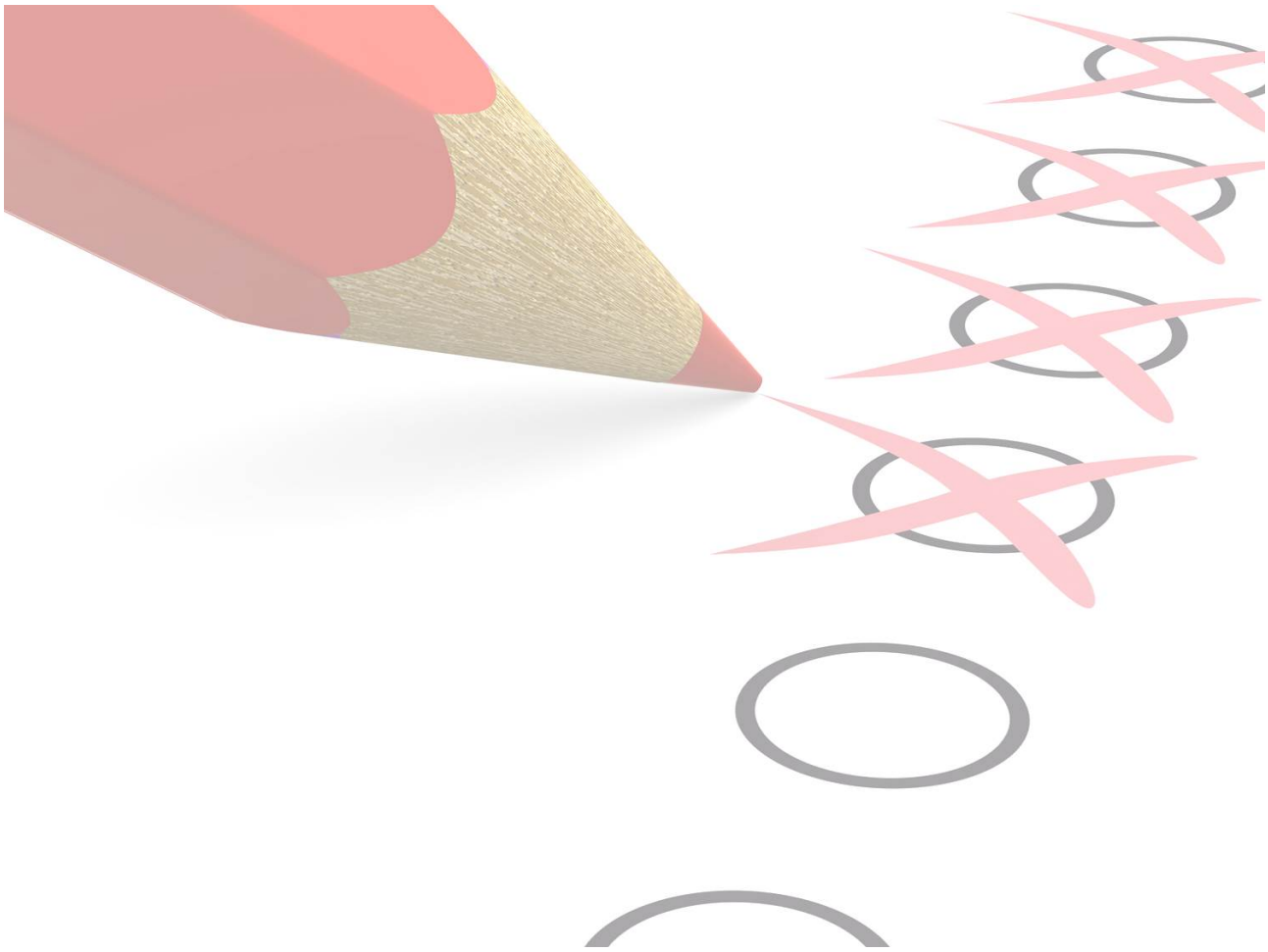
Diagnostic screening tool for lumbar spinal stenosis



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Background

The term Lumbar Spinal Stenosis (LSS) refers to spinal osteoarthritis that narrows the central spinal canal, the lateral recess or the intervertebral foramen. The decrease in the total area of the spinal canal can lead to compression of the associated neurovascular structures and inflammation of soft tissue structures causing neurogenic claudication, which is the main symptom of LSS and described as lower limb pain and neurological symptoms increased by walking [1] and often with symptom relief when sitting or flexing the spine. Additional symptoms can include numbness, fatigue, impaired balance, muscle weakness and back pain [2]. LSS remains a clinical diagnosis but Magnetic Resonance Imaging (MRI) is often used in the diagnosis of LSS as it can provide information on the presence and extent of degenerative spinal disease [3].

LSS can cause significant pain and disability leading to dramatically reduced quality of life, immobility and functional limitation. Patients seeking care for LSS are treated with either surgery or one or more non-surgical treatment option such as oral medication, acupuncture, stretching and muscle strengthening exercises, cardiovascular training and manual treatments. However, in a new National Clinical Guideline from the Danish Health Authorities on treatment of lumbar spinal stenosis no or only limited evidence of low quality was found, and the authors conclude that there is a urgent need for research in all aspects of the disease[4].

LSS seems to be a highly prevalent condition although the true prevalence is unknown. According to the national Danish spine surgery registry 'DaneSpine' [5] LSS is currently the main reason for lumbar spinal surgery in Denmark. Some data indicates that 13-14% of patients with low back pain who see a spine specialist has LSS and that the number is 3-4% of those who see a general physician [6]. In a study estimating the number of people over 60 years of age with LSS in the general population the prevalence ranged from 18-49% depending on the diagnostic criteria used [7]. The number of people with pain and disability due to LSS is expected to increase with age due to the degenerative nature of the disease. With an aging population this could potentially become a major health economic challenge as nearly 30% of the Danish population will be over the age of 60 in year 2030[8].

One of the challenges to estimate the true prevalence is the lack of a valid and reliable gold standard for LSS. MRI is often used as diagnostic confirmation and procedure planning for patients considering spinal surgery, but is not a gold standard for the diagnosis of LSS. This is because anatomic spinal stenosis is often found in asymptomatic people[9] and therefore LSS remains a clinical diagnosis.

In 2007, Konno et al.[10, 11] developed a 10-question diagnostic support tool to identify lumbar spinal stenosis and discriminate LSS from overlap symptoms of radicular pain and cauda equina symptoms by means of a self-reported history questionnaire. In 2016, Aizawa et al. [12] developed a 15-question diagnostic support tool designed to identify patients with leg symptoms caused by either LSS or lumbar disc herniation and to discriminate the two conditions. The questionnaire was

reported to perform well with sensitivity and specificity for LSS calculated to be 97.2% and the specificity is 84.7% and AUC 0.95 (95% CI 0.93 to 0.98) and negative likelihood ratios at 6.1 and 0.1. To our knowledge, no diagnostic screening tool designed to estimate the prevalence of LSS in a clinical population of Danish patients with chronic LBP and leg pain has been developed.

Objective

The objective of this project is to develop a diagnostic screening tool for LSS – the LLS Screen. This should consist of a set of items useable in a self-administered questionnaire, a rule to compute the probability of having LSS, and a cutpoint to be used to obtain a sensitivity of 95%. The rule should be applicable in patient populations suffering from low back pain and with increased suspicion to suffer from LSS due to failure of non-surgical treatment.

The specific objectives are:

A. To identify items with high content validity for diagnosing LLS
B. To investigate the preliminary value of items included in the LLS screen
C. To investigate the performance of the included items in the LLS screen
D. To decide on the content of the final version of the LLS Screen

Method

This project consists of four parts. Part I addresses objective A based on a literature search and qualitative semi-structured interviews. Part II addresses objective B by conducting a case-control study concurrent with a cohort study and performing a series of analyses to investigate the preliminary value and performance of the items. Part III describes the performance of the items by combining them in various ways to obtain an optimal diagnostic rule (objective C). Finally, part IV is a decision of the content of the final version of the LSS Screen based on information from Part I, II and III (objective D).

Study setting and population

Recruitment of patients will primarily take place from a publicly-funded outpatient secondary care spine clinic (the Spine Centre of Southern Denmark). Patients with persistent spinal pain are referred to the Spine Centre from general physicians and chiropractors in primary care if they have received relevant non-surgical treatment without achieving the expected effect. Also, patients with LSS will be recruited from other hospital departments not yet defined. Due to the degenerative nature of LSS the prevalence increases with age and are not often seen under the age of 50[7]. Therefore, patients in this study will be above 50 years of age and the screening questionnaire will be targeted to this age group.

Part I. Item development

Aim

To define a set of items characterized by high content validity and applicability in a self-administered questionnaire

Design

Literature search and qualitative semi structured interview.

Content validity

Screening questionnaires including symptoms of LSS has already been developed [10, 12] as well as an International Delphi Study regarding consensus on clinical diagnosis of LSS [13]. Therefore, we did not repeat the process of identifying relevant history questions of LSS but selected a broad spectrum of 36 (Table 1) existing diagnostic screening questions. The literature was searched to identify papers reporting on diagnostic criteria of LSS.

Question reduction will be carried out by merging questions covering the same topic, removing questions with direct overlap and excluding questions not directly associated with LSS symptoms or requiring a physical examination resulting in a list of pre-final screening question. A preliminary draft of the process is shown in Appendix 1.

The pre-final screening questions will undergo a crude translation and/or rephrasing from English to Danish. Also, face validity of the questionnaire will be assessed, and changes will be carried out accordingly.

A series of semi-structured interviews with patients with LSS will conducted for patients to assess the final questions and be interviewed about their understanding of the phrasing, the appropriateness of the questions in relation to LSS symptoms and if symptoms are covered sufficiently. An interview guide in Danish is shown in Appendix 2.

Patient recruitment

Patients participating in the interview will be recruited from the Spine Centre of Southern Denmark. The clinician examining the patient will ask if the patient would like to participate in a short interview regarding the development of a screening questionnaire for LSS. If the patient agrees, one of the authors will conduct the interview. Based on the experience from previous interviewers it is estimated that 4-5 patients will be sufficient, however, should new themes arise during the last interviews the number will be extended until no new information comes up or until a maximum of 10 LSS patients are reached.

Based on the feedback from this process a test-version of the questionnaire will be developed. Appendix 3.

Table 1: Questions or symptoms identified in relevant literature (36 items)

SOURCE	Q	QUESTION OR SYMPTOM
KONNO S. ET AL.	1	Numbness and/or pain in the thighs down to the calves and shins.
	2	Numbness and/or pain increase in intensity after walking for a while but are relieved by taking a rest.
	3	Standing for a while brings on numbness and/or pain in the thighs down to the calves and shins.
	4	Numbness and/or pain are reduced by bending forwards.
	5	Numbness is present in both legs.
	6	Numbness is present in the soles of both feet.
	7	Numbness arises around the buttocks.
	8	Numbness is present but pain is absent.
	9	A burning sensation arises around the buttocks.
	10	Walking nearly causes urination.
AIZAWA T. ET AL.	11	Difficulty bending forward because of numbness and/or pain.
	12	Difficulty putting on socks because of numbness and/or pain.
	13	Numbness and/or pain increase in intensity after walking for a while, but are relieved by taking a rest.
	14	Standing for a while brings numbness and/or pain in the thigh(s) down to the calf or calves and shin(s).
	15	Numbness and/or pain are reduced by bending forward.
	16	Numbness is present, but pain is absent.
	17	Numbness and/or pain is present in both legs.
	18	Numbness is present in the soles of both feet.
	19	Numbness arises around the buttocks.
	20	I am ≥ 60 years old.
TOMKINS-LANE C. ET AL.	21	Does the patient have leg or buttock pain while walking?
	22	Does the patient flex forward to relieve symptoms?
	23	Does the patient feel relief when using a shopping cart or bicycle?
	24	Does the patient have motor or sensory disturbance while walking?
	25	Are the pulses in the foot present and symmetric?
	26	Does the patient have lower extremity weakness?
	27	Does the patient have low back pain?
SANDELLA D. ET AL.	28	Leg pain while walking
	29	Must sit down or bend forward to relieve pain
	30	Flex forward while walking
	31	Normal pulses in foot

GENEVAY S. ET AL.	32	Low back pain
	33	Lower extremity weakness
	34	Patient reports pain in both legs
	35	Patient reports leg pain relieved by sitting
	36	Patient reports leg pain decreased by leaning forward or flexing the spine

Part II. Preliminary assessment of the potential value

Aim

A "proof of principle" with respect to a potentially sufficient diagnostic value of the selected items when considered to be used for screening for LSS. In case of a failure of such a proof, the cohort study should be stopped, as it is not ethical and inconveniencing to force patients and personnel collecting data on hundreds of patients if the screening tool is already known to be of limited value.

Design

A case-control study with cases and controls identified within a prospective clinical population based cohort study that will be boosted with cases of LSS.

Patient recruitment

For this part of the study the patients will be recruited in two ways.

Cohort design

First, a prospective clinical population based cohort of patients with low back pain and/or leg pain will be initiated. Patients above 50 years of age will be included in the study at their first visit at the Spine Centre where they fill out the screening questionnaire (index test) before they are seen by a clinician. The primary diagnosis (reference test) will be assessed and determined by specialists at the Spine Centre.

Case-control design

Secondly, patients with LSS will be recruited from other departments to artificially increase the prevalence of LSS. Patients with LSS will be recruited from the surgical department at the Spine Centre in Middelfart. Also, an attempt will be made to recruit patients with LSS from the Medical Department, Section for arthritis, connective tissue disease and spinal disorders at Slagelse Hospital, Surgical Department, Silkeborg Regional Hospital and Department of Spine Surgery, OUH, Odense.

Limitations

We may expect that cases recruited from medical departments are similar to those cases we identify as part of the cohort study. However, there may be already here a selection towards more severe or less ambiguous cases. In any case, we have to expect that patients from surgical departments represent more severe cases. Consequently, we will overestimate the diagnostic accuracy in comparison to the cohort study. However, as we use the case control study only to identify futility, this overestimation cannot result in an erroneous stopping of the cohort study.

Inclusion and exclusion criteria

Cohort design

Patients will be included in the study if their primary complaint is pain in the lumbar spine and/or leg(s). This is due to practical reasons as patients are registered in SpineData based on their primary complaint which the patient indicates by choosing the primary area of pain on an electronic pain drawing when entering the questionnaire.

Case-control design

Cases recruited from the surgical departments will be included in the study if they are scheduled for surgery due to lumbar spinal stenosis. Cases recruited from other medical departments than the Spine Centre will be included if they are categorised as LSS-patients according to the Reference standard and had pain in the lumbar spine and/or leg(s) as their primary complaint.

Patients included should be able to read and write Danish to be able to answer the questionnaire in Danish.

Table 2: Inclusion criteria

LSS patients – surgical	LSS patients - medical	Non-LSS patients
• Able to read and write Danish • Age above 50 • LSS according to reference standard • Awaiting surgery for LSS	• Able to read and write Danish • Age above 50 • Low back pain and/or leg pain • LSS according to reference standard	• Able to read and write Danish • Age above 50 • Low back pain and/or leg pain • No LSS according to reference standard

Data collection

Cohort design

Patients who visit the medical department at the Spine Centre, fill out a standardised evaluation form in a clinical registry (SpineData)[14]. SpineData is an internet-based system that captures patient data electronically at the point of clinical contact. The test-version (index-test) of the LSS screening questionnaire will be part of the standardised evaluation form. The patient will fill out

the evaluation form either the day before their visit to the Spine Centre or in the waiting room before the first contact with a clinician.

Patients with LBP who are above 50 years of age will be assigned to clinical examination by selected clinicians at the Spine Centre who will perform the reference test, diagnosis and data collection. The selected clinicians will be those with the most clinical experience who will volunteer for participation in the data collection. If there are more patients with LBP and/or leg pain who are >50 years, than the selected clinicians have time in their programs to assess, the patients will be assessed by other clinicians and thereby not be part of the study. Therefore, not all patients who have filled out an index test will be included in the study population. However, the selection will be random as it is based on the number of clinicians at work and consecutively referral of patients from primary care to the Spine Centre.

After the clinical contact with the patient, the clinician will fill out a questionnaire with a predefined list of clinical symptoms and diagnosis. They will also provide information on LSS being confirmed with an MRI, although MRI is not necessary to be included as LSS patient due to the clinical nature of the diagnosis.

Data from the clinicians will be collected using a SpineData module developed for clinicians to fill out. See Appendix 4 for clinician questionnaire.

Case-control design

Patients who are recruited from other departments will fill out either an electronic version or a paper version of the questionnaire. If electronic data collection is preferred the web-based data collection system “SurveyXact” (Rambøll Management Consulting, Århus) will be used.

A contact person on each department will organise the data collection. Patient information and questionnaire for data collection is shown in Appendix 5.

Reference standard

Patients will be categorised as LSS-patients by the clinician if they have clinical symptoms of LSS (neurogenic claudication) based on diagnostic criteria in line with the recent suggestions of clinical diagnosis of LSS[13, 15, 16]. The diagnosis of LSS is a clinical assessment primarily based on key items of the case history and ruling out differential diagnosis by a clinical examination:

- Pain, motor or sensory disturbance in one or both legs or buttock(s) while walking and standing
- Forward flexion of the spine relieves symptoms
- Symptom relieve when sitting
- Clinical examination does not indicate:
  - vascular claudication
  - cox arthrosis
  - radiculopathy due to disc herniation

- greater trochanteric pain syndrome

Case history

In a clinical consultation the case history is obtained by dialog between patient and clinician by asking open questions about symptoms: “Can you describe your symptoms?”, “Are there factors or activities that will worsen your symptoms?”, “Are there situations or positions where you feel less symptoms?” etc. If the patient does not describe a classic symptom of neurogenic claudication such as fx. decreasing the symptoms by leaning forward or flexing the spine, the clinician will often ask more specific questions about the movement but without providing the patient with the “right” answer: “Does it change your symptoms when you flex forward?”, “Does the symptoms get worse, better or unchanged when you flex forward?”. Also, the clinician would sometimes ask the patient to flex the spine and ask the patient to notice any change in the symptoms.

Clinical examination

Patients with neurogenic claudication will often have normal examination findings. Sometimes extension will provoke leg symptoms and if the symptoms are severe there can be neurological deficits such as sensory disturbance or reduced muscle strength in the legs. The clinical examination is also used to rule out differential diagnosis. Vascular claudication can mimic the symptoms and are considered in the case history (relieve of symptoms with stop when walking without sitting or leaning forward, worsening of symptoms when biking) but also by examining pulse in legs and feed. Other potential differential diagnosis such as hip arthritis and greater trochanteric pain syndrome will be tested in the same way by specific clinical examination tests.

Variables of interest

Cohort design

Data collected from the patient

The following data will be collected either electronically by SpineData or on paper if the patient prefer: SpineData ID number, date, Index test, age, sex, physical function measured by Oswestry Disability Index (ODI), back- and leg pain measured on an 11-point numerical rating scale (NRS) (“Typical low back pain intensity in the last 14 days” and “Typical leg pain intensity in the last 14 days”), and level of physical activity measured with the question “What is the intensity of the physical activity in your recreational activities?” with four answer options (1: “I normally sit and read, watch television, go to the movies, or spend my leisure time with quieter activities”, 2: “I walk, take short trips on the bicycle or do other kinds of physical activities at least 4 hours a week”, 3: “I am physically active with running, swimming, tennis / badminton at least 3 hours a week. If I don’t do sport but often do heavy work in the garden or other heavy work in my leisure time, I also belong to this group.”, or 4: “I do competition sports, or swim, bike, or run long distances multiple times a week”. Also, information on the work situation with the following question will be collected: “What is your present work situation?” (1: Ordinary job - fulltime or

part time | 2: Flexjob | 3: Studying | 4: Undertaking rehabilitation | 5: Unemployed | 6: Receiving disability pension | 7: Receiving retirement pension | 8: Housewife or househusband | 9: Other).

Data collected from the clinician

Following the examination, the clinician will provide clinical information and a diagnosis by answering yes or no to questions described below.

Clinical information: "Does the patient have i) low back pain, ii) pain or sensory disturbance in one leg, iii) pain or sensory disturbance in both legs?"

Diagnosis: "Does the patients have symptoms of neurogenic claudication ad modum reference standard?". The clinician will provide information on the level of the diagnostic certainty measured in percentages by marking a visual analogue scale from 0% to 100% ("How sure are you of the diagnosis?").

MRI: As neurogenic claudication is a clinical symptom the diagnosis does not require confirmation by MRI. However, confirmation of the diagnosis by MRI would probably influence the diagnostic certainty and information on MRI is therefore collected by asking: i) "Have the patient had an MRI?" and ii) "Does the MRI confirm the diagnosis?".

Case-control design

Data collected from the patient

Paper versions of the Index test (with age-groups) as well as sex will be collected from patients who are diagnosed with LSS.

Table 3: Variables of interest

	Part II Cases from other departments	Part II/III Cases and controls from SpineCentre	Part III Cohort
SpineData ID number		X	X
Date		X	X
Age or agegroups	X	X	X
Sex	X	X	X
Index test (LSS Screen is up to 13 questions)	X	X	X
Reference test		X	X
Physical function, ODI (0-100)		X	X
Typical back pain last 14 days, NRS (0-10)		X	X
Typical leg pain last 14 days, NRS (0-10)		X	X
Physical activity leisure time (4 response options)		X	X
Physical activity at work (4 response options)		x	x
Present work situation (9 response options)		X	X

ODI: Oswestry Disability Index. NRS: Numerical Rating Scale

Sample size

We intend to include a minimum of 100 cases and 100 controls. 100 cases will allow to estimate a sensitivity of 0.95 with a standard error of 0.022. One hundred controls will allow to estimate a specificity of 0.7 with a standard error of 0.046.

Analysis plan

The primary analysis will be the application of a logistic regression model combining all items in a linear manner (with age as continuous variable) and the determination of the corresponding AUC by a 10-fold cross validation. In addition, the specificity corresponding to a cut point with 95% sensitivity will be determined. The continuation of the cohort study will be regarded as justified if we can reach a specificity of at least 68%, such that we can expect in the cohort setting with a prevalence of 10% a positive predictive value above 25% and a frequency of positive test results of 39%.

In the case of a decision to continue the cohort study, we will in addition perform the first three analyses planned for the cohort study also in the case control study to get an impression about the value of the single items. In case a single item turns out to be very uninformative (due to very low/high prevalence and no association to the case-control status) it might be decided to remove this item from the questionnaire.

We will also describe the distribution of additional variables in LSS and non-LSS patients in tabular form.

In the case of a decision not to continue the cohort study, we will prepare a publication about the negative results from the case control study, which may include additional analyses planned for the cohort study.

In order to ensure that the case-control study can be analysed quickly in order to make a decision about the continuation of the cohort study, we will start to prepare the analysis as soon as data from 100 patients are available, i.e. starting to clean the data continuously and creating all necessary do-files to conduct the analyses.

Part III. Performance of the questionnaire

Aim

To describe the utility of the items with respect to contributing to a rule allowing to compute the probability of having LSS and applicable in the relevant patient population.

Design

This part of the study will be designed as a cohort study in a relevant population.

Patient recruitment

Patients with low back pain and/or leg pain will be included in the study at their first visit at the Spine Centre. Patients recruitment procedure are described in Part II.

Data collection

Data will be collected from the patients and clinicians using SpineData as described in Part II.

Variables of interest

Variables collected from both patients and clinicians are described in Part II. Table 3 is an overview of the variables collected.

Sample size

According to the general wisdom about the construction of prediction rules [17-19], we aim at including 10 cases per item to be included in the model. With 13 items to be considered, this results in 130 cases. With an assumed prevalence of 10% a total of 1300 patient are needed. However, should the prevalence be higher than estimated we will downgrade the total number of patients accordingly.

Analysis plan

Descriptive data on all items and all additional variables will be tabulated for the included patients and the patients excluded due to lack of capacity in the clinic.

Descriptive data on all additional variables comparing LSS patients and non-LSS patients will be tabulated.

To inform the final decision in Part IV the following analyses will be performed:

- Description of the diagnostic value of each binary item by prevalence, sensitivity, specificity and the diagnostic odds ratio. (All conditional items will be reported only in the subpopulation where the item could be filled. Age will be dichotomized at the median.)
- Description of the diagnostic value of each binary item beyond age by the diagnostic odds ratio adjusted for age.
  Description of the independent value of each binary item by reporting the odds ratio from a multivariate logistic model with adjustment for all other items (full model). Since the condition triggering conditional items is included in the model, all items can be included. The value of the question about leg pain/irritation will be described by reporting the difference between subjects with no leg pain and the average subject with leg pain/irritation.
- Handling pain elicitation by walking and/or standing in a logistic model comparing the four variants
    - Pain elicitation as a single binary indicator
    - Walking/standing as a 0-1-2 variable (none- one – both)

    - Walking/standing as two binary covariates (as in the original full model)
    - Walking/standing as one categorical variable (nothing, walking only, standing only, waking & standing)

  The comparison will be based on cross validated AUC values in a model with adjustment for age and in a model with adjustment for all other items. In addition the odds ratios from the models are reported.
- Handling pain reduction by bending forward, sitting, cycling, and/or using shopping cart in a logistic model comparing the five variants
    - Reduction by any activity as a single binary indicator
    - Number of activities leading to reduction as a continuous variable
    - Number of activities leading to reduction and its square as continuous variables
    - Each activity as a binary covariate (as in original full model)
    - Each activity as a binary covariate and "3 or more activities" as a binary covariate
- Handling of age in a non-linear manner by using a Fractioned Polynomial approach.
- Potential for overlooked diagnostic potential due to deviations from additivity and linearity by considering the cross validated AUC when using a random forest approach and when using the linear prediction from the full model as input to a Fractioned Polynomial approach.
- In case the analyses on handling variables give rise to a simpler or more complex modelling than the original full model, all steps will be repeated with a new definition of the full model.
- Use of Tibshirani's lasso to study the cross validated AUC as a function of the number of items to be included (within the full model). Both the AUC as well as the trajectories of the estimates will be reported.
- Description of the diagnostic value of the additional variables by reporting their odds ratios when adding the variable to the full model.
- Investigating the potential of differential item functioning by adding for each item the interactions with age, gender, and physical activity, respectively, in the full model and reporting the subgroup specific odds ratio and p-values for interactions.
- The main analyses will be repeated including only those 80% of patients for whom the clinicians indicated maximal sureness.

All reported estimates will be supplemented by confidence intervals and p-values (when available). Cross validation refers to a 10-fold cross validation repeated 10 times. In addition to the AUC also the specificity, the positive predictive value and the prevalence of positive findings when using a cut-point resulting in a sensitivity of 95% will be reported.

In case of discrepancies between the clinical diagnosis and the MRI results, we will conduct a sensitivity analysis relying on the MRI results instead of the clinical diagnosis. In case of borderline

results, we will also conduct an analysis where the cases are enriched by the additional cases from medical departments of the case-control study in Part II.

Limitations

Since we have some freedom in how to combine the items into the rule and limited a priori knowledge about the best way, we cannot pre-specify one model in advance and have to allow manual decision on the final model. This way we will not be able to report unbiased estimates of the diagnostic accuracy of the final model.

The diagnostic probability rule will only apply to populations similar to the one included in the cohort study. Since other health care systems do not offer centralized care in a fashion similar to our Spine Centre, the applicability of the probability rule will be limited. We try to describe our patient population as best as possible with respect to symptoms, disease and treatment history in order to give a clear picture about the patient population for which the probability rule is applicable. We will report the cut-point on a raw score scale in order to facilitate its application in other populations. The sensitivity of the cut-point depends only on the selection of cases, and hence will hold also in patient populations with a different mix of cases and controls, as long as the cases are comparable to the cases in our cohort study.

Part IV. Content of the final version of the LLS Screen

The final decision on the items to be included in the questionnaire and on the type of model to be used in the diagnostic probability rule will be based on a consensus among the research team members based on the results of Part III.

Ethics

The Regional Scientific Ethics Committee for Southern Denmark states on their webpage that this type of study do not require ethical approval [17]. The study will conform to the standards set by the Declaration of Helsinki. The project includes only legally competent, consenting patients, and participation is voluntary. Written consent will be collected.

The Danish Data Protection Agency will be notified of the project by application from SDU. Data collected from other participating hospital departments than SpineCentre of Southern Denmark, medical department, will be anonymous. The results will be published in international peer-reviewed journals and communicated to relevant healthcare professionals by relevant media.

Time plan

The project will begin as soon as possible and include patients throughout 2019.

Part I: We expect to recruit 5 patients per month willing to participate in an interview and therefore expect this part will be conducted during the first and second month.

Part II: We estimate the prevalence of LSS to be approximately 10% in an age group above 50. We plan on recruiting 5 full time clinicians who can assess a total of approximately 40 relevant patients per week, which gives us 36 non-LSS and 4 LSS patients. We estimate that around 25% will refuse to participate which will give us 27 non-LSS patients and 3 LSS patients per week. It would take approximately 4 weeks to collect 100 non-LSS patients. We estimate that other departments can deliver 2-3 LSS-patients per week and we plan on 3 additional departments which is a total of 9-12 LSS patients per week. 100 LSS patients would therefore take 8-12 weeks to include. Data collection on LSS patients from additional departments would start at least one month before starting the cohort study, such that four weeks after starting the cohort study we can expect to have about 100 cases and 100 controls and hence be able to start analysis of the case control study. Our aim is to start data collection from additional departments in January 2019 and to start the cohort study at the Spine Centre around February 2019, however adjusted according to the speed of including cases during the first month. Consequently, we expect to be able to start analysing the case-control study around February.

Part III: As described in Part II, we estimate that clinicians at the Spine Centre will be able to include 3 LSS patients per week. It would then take 43 weeks to include 130 LSS patients. However, including holidays and other responsibilities for the clinicians a data collection period at 12 months would be more realistic. If we start the cohort study in January 2019 we will finish the cohort study around December 2019, because we can keep the patients included from the Spine Centre in Part II.

Data analysis and writing process will be conducted in 2019 and 2020 and the project will finish summer 2020.

Appendix 1

Link between original and new questions

Link between the 36 questions and the selected 13 items for the questionnaire in appendix 3.

	15 selected items (appendix 3)	36 questions (Table 1)		
Q1	Hvor gammel er du _____			
		I am ≥ 60 years old.	Q20	Aizawa et al. [12]
Q2	Har du sommetider smerter eller føleforstyrrelser i ét eller begge ben eller balder?			
Q3	Har du smerter eller føleforstyrrelser i **begge** ben eller balder?			
		Numbness and/or pain in the thighs down to the calves and shins.	Q1	Konno et al.[11]
		Numbness and/or pain is present in both legs.	Q17	Aizawa et al. [12]
		Patient reports pain in both legs	Q34	Genevay et al.[16]
		Numbness is present in both legs.	Q5	Konno et al.[11]
		Numbness arises around the buttocks.	Q7	Konno et al. [11]
		Numbness arises around the buttocks	Q19	Aizawa et al. [12]
Q4	Har du føleforstyrrelser under begge fødder?			
		Numbness is present in the soles of both feet.	Q6	Konno et al. [11]
		Numbness is present in the soles of both feet.	Q18	Aizawa et al. [12]
Q5	Har du smerter eller føleforstyrrelser i ét eller begge ben når du går?			
		Does the patient have leg or buttock pain while walking?	Q21	Tomkins-Lane et al. [2]
		Leg pain while walking	Q28	Sandella et al. [15]
Q6	Har du smerter eller føleforstyrrelser i ét eller begge ben eller balder, når du har stået i noget tid?			
		Standing for a while brings on numbness and/or pain in the thighs	Q3	Konno et al. [11]

		down to the calves and shins		
		Standing for a while brings numbness and/or pain in the thigh(s) down to the calf or calves and shin(s).	Q14	Aizawa et al. [12]
Q7	Lindres dine smerter eller føleforstyrrelser, når du bøjer dig fremover?			
		Numbness and/or pain are reduced by bending forwards.	Q4	Konno et al. [11]
		Numbness and/or pain are reduced by bending forward.	Q15	Aizawa et al. [12]
		Does the patient flex forward to relieve symptoms?	Q22	Tomkins-Lane et al. [2]
		Must sit down or **bend forward** to relieve pain	Q29	Sandella et al. [15]
		Patient reports leg pain decreased by leaning forward or flexing the spine	Q36	Genevay et al. [16]
	Q1+Q2 (risk of local dependence)	Numbness and/or pain increase in intensity after walking for a while but are relieved by taking a rest	Q2	Konno et al.[11]
	Q1+Q2 (risk of local dependence)	Numbness and/or pain increase in intensity after walking for a while, but are relieved by taking a rest.	Q13	Aizawa et al. [12]
Q8	Lindres smerterne eller føleforstyrrelserne, når du sidder?			
		Patient reports leg pain relieved by sitting	Q35	Genevay et al. [16]
Q9	Lindres dine smerter eller føleforstyrrelser i ét eller begge ben, når du cykler?			
Q10	Lindres dine smerter eller føleforstyrrelser i ét eller begge ben, når du læner dig ind over indkøbsvognen?			
		Does the patient feel relief when using a shopping cart or bicycle?	Q23	Tomkins-Lane et al. [2]
Q11	Bøjer du dig forover, mens du går?			

		Flex forward while walking	Q30	Sandella et al. [15]
Q12	Får du ”tunge ben” når du går?			
		Does the patient have lower extremity weakness?	Q26	Tomkins-Lane et al. [2]
		Lower extremity weakness	Q33	Sandella et al. [15]
		Does the patient have motor or sensory disturbance while walking?	Q24	Tomkins-Lane et al. [2]
Q13	Har du lændesmerter?			
		Does the patient have low back pain?	Q27	Tomkins-Lane et al. [2]
		Low back pain	Q32	Sandella et al. [15]
	NOT INCLUDED			
	Question related to cauda equina symptoms	A burning sensation arises around the buttocks.	Q9	Konno et al. [11]
	Question related to cauda equina symptoms	Walking nearly causes urination.	Q10	Konno et al. [11]
	Question related to symptoms on disc herniation	Difficulty bending forward because of numbness and/or pain.	Q11	Aizawa et al.[12]
	Not clear how it differentiates	Numbness is present, but pain is absent.	Q8 Q15	Konno et al. [11] Aizawa et al. [12]
	Question related to symptoms on disc herniation	Difficulty putting on socks because of numbness and/or pain.	Q12	Aizawa et al. [12]
	Related to physical examination	Are the pulses in the foot present and symmetric?	Q25	Tomkins-Lane et al. [2]
	Related to physical examination	Normal pulses in foot	Q31	Sandella et al.[15]

Appendix 2

Semistructured interview guide

Tidtagning af udfyldelse

Min._____

Spørgsmål

1. Prøv at beskriv med dine egne ord hvad du forstår ved spørgsmålet?

Spørgsmål nr.	Beskriv hvis der er diskrepans mellem spørgsmålets intention og det der beskrives

2. Synes du spørgsmålet er relevant i forhold til dine symptomer?

Spørgsmål nr.	Hvorfor er spørgsmålet ikke relevant?

4. Har du oplevet andre symptomer, smerter eller lignende som vi ikke spørger ind til i spørgeskemaet?

Beskriv kortfattet hvad der svares

_____

_____

_____

_____

5. Har du en afsluttende kommentar eller noget, du føler, at du vil have med, inden vi afslutter samtalen?

Beskriv kortfattet hvad der svares

_____

_____

_____

_____

6. Manglende besvarelse af et eller flere spørgsmål: Hvorfor har du ikke svaret på dette spørgsmål?

Beskriv kortfattet hvad der svares

_____

_____

_____

_____

7. Andet relevant, der kommer op.

Beskriv

_____

_____

_____

_____

Appendix 3

Draft version of final questionnaire

Ved hvert spørgsmål skal du sætte kryds i "ja" eller "nej" for at angive, om du har oplevet symptomet indenfor den sidste måned. Vi spørger både til smerter og føleforstyrrelser. Ved føleforstyrrelser mener vi prikken, stikken, snurren eller følelsesløshed.

1. Hvor gammel er du? _____år

		Ja	Nej
2.	Har du smerter i lænden?	☐	☐
3.	Har du sommetider smerter eller føleforstyrrelser i ét eller begge ben eller balder? **(Hvis nej til spørgsmål 3, så er du færdig med spørgeskemaet)**	☐	☐

De næste spørgsmål handler om, hvor du mærker dine **symptomer** dvs. smerter eller føleforstyrrelser.

4.	Har du smerter eller føleforstyrrelser i **begge** ben eller balder?	☐	☐
5.	Har du føleforstyrrelser under **begge** fødder?	☐	☐

De næste spørgsmål handler om hvad der kan **forværre** dine smerter eller føleforstyrrelser.

6.	**Forværres** dine smerter eller føleforstyrrelser i ét eller begge ben eller balder når du:		
	a) går?	☐	☐
	b) har stået i noget tid?	☐	☐

De næste spørgsmål handler om hvad der kan **lindre** dine smerter eller føleforstyrrelser.

7.	**Lindres** dine smerter eller føleforstyrrelser i ét eller begge ben eller balder når du:		
	a) bøjer dig fremover?	☐	☐
	b) sidder?	☐	☐
	c) cykler?	☐	☐
	d) læner dig ind over indkøbsvognen?	☐	☐

De næste spørgsmål handler om hvad der sker **når du går**.

8.	Bøjer du dig forover, mens du går?	☐	☐
9.	Får du "tunge ben" når du går?	☐	☐

Tak for din besvarelse!

Appendix 4

Kliniker skema

Patientens CPR-nr: _____

Har patienten:

1. Lænderygsmerter?

☐ ☐
Ja Nej

2. Bensmerter/føleforstyrrelser bilateralt?

☐ ☐
Ja Nej

3. Bensmerter/føleforstyrrelser unilateralt?

☐ ☐
Ja Nej

4. Har patienten neurogen claudicatio*?

☐ ☐
Ja Nej

5. Hvor sikker er du på din diagnose? (markér som procent på linjen)**

6. Er der lavet MR skanning af lænden?

☐ ☐
Ja Nej

7. Er diagnosen bekræftet på MR (du synes din diagnose passer med MR fund)?

☐ ☐
Ja Nej

*Neurogen claudicatio:

- Smerter og/eller føleforstyrrelser i ét eller begge ben og/eller balde(r), som forværres i gående og stående stilling.
- Fleksion af lænden samt siddende stilling lindrer symptomerne.

Appendix 5

Projektinformation

Kære patient

Vi vil spørge om du vil deltage i et forskningsprojekt?

Din deltagelse omfatter at du udfylder et spørgeskema med 10 spørgsmål. Spørgeskemaet er på bagsiden.

Formål

Vi ønsker at udvikle et spørgeskema, der skal kunne skelne patienter, som har "lumbal spinalstenose" fra patienter som ikke har det. Lumbal spinalstenose er en forsnævring af rygmarvskanalen, der kan opstå i takt med at man bliver ældre. Forsnævringen kan medføre smerter og ubehag samt problemer med den fysiske funktion.

Hvilke oplysninger indsamler vi

De 10 spørgsmål omfatter helbredsoplysninger som relaterer sig til patienter med symptomer på lumbal spinalstenose.

Vi indsamler ikke personoplysninger som navn, cpr-nummer eller adresse, og din besvarelse vil derfor være anonym.

Hvad indebærer din deltagelse

- Deltagelse påvirker ikke den behandling du får.
- Du skal udfylde spørgeskemaet på bagsiden.

Hvordan behandles dine oplysninger

Data videregives kun til forskere fra Syddansk Universitet.

Alle oplysninger bliver anonymiseret, så det ikke fremgår af de indsamlede data, hvem der har bidraget til projektet.

Forskningsprojektet forventes afsluttet i 2020.

Dine rettigheder

Deltagelse er frivillig, og vil ikke påvirke din videre behandling.

Da vi ikke indsamler data som senere kan identificere dig, vil din besvarelse være anonym.

Kontaktperson

Kontaktperson er projektleder Rikke Krüger Jensen, Syddansk Universitet.

Du kan kontakte os på email: rikkekruger@nikkb.dk

Spørgeskema

Ved hvert spørgsmål skal du sætte kryds i "ja" eller "nej" for at angive, om du har oplevet symptomet indenfor den sidste måned. Vi spørger både til smerter og føleforstyrrelser. Ved føleforstyrrelser mener vi prikken, stikken, snurren eller følelsesløshed.

1. Er du mand ☐ eller kvinde ☐ ?

2. Hvor gammel er du?

≤50 år ☐ 51-55 ☐ 56-60 ☐ 61-65 ☐ 66-70 ☐ 71-75 ☐ 76-80 ☐ 81-85 ☐ ≥85 ☐

		Ja	Nej
3.	Har du smerter i lænden?	☐	☐
4.	Har du sommetider smerter eller føleforstyrrelser i ét eller begge ben eller balder? **(Hvis nej til spørgsmål 3, så er du færdig med spørgeskemaet)**	☐	☐

De næste spørgsmål handler om, hvor du mærker dine **symptomer** dvs. smerter eller føleforstyrrelser.

5.	Har du smerter eller føleforstyrrelser i **begge** ben eller balder?	☐	☐
6.	Har du føleforstyrrelser under **begge** fødder?	☐	☐

De næste spørgsmål handler om hvad der kan **forværre** dine smerter eller føleforstyrrelser.

7.	**Forværres** dine smerter eller føleforstyrrelser i ét eller begge ben eller balder når du:		
	a) går?	☐	☐
	b) har stået i noget tid?	☐	☐

De næste spørgsmål handler om hvad der kan **lindre** dine smerter eller føleforstyrrelser.

8.	**Lindres** dine smerter eller føleforstyrrelser i ét eller begge ben eller balder når du:		
	a) bøjer dig fremover?	☐	☐
	b) sidder?	☐	☐
	c) cykler?	☐	☐
	d) læner dig ind over indkøbsvognen?	☐	☐

De næste spørgsmål handler om hvad der sker **når du går**.

9.	Bøjer du dig forover, mens du går?	☐	☐
10.	Får du "tunge ben" når du går?	☐	☐

Tak for din besvarelse

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