

Prognostic indicators for patients with degenerative lumbar spinal stenosis

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Chapter 9

Valorization addendum

Relevance

The goal of this thesis was to investigate several potential prognostic indicators within the scope of the Lumbar Stenosis Outcome Study (LSOS) [1]. The results of our studies will be used to improve patient outcomes and to contribute to a valid prognostic model in order to estimate the probabilities of different treatment regimes in patients with LSS.

Lumbar spinal stenosis (LSS) is a highly prevalent condition affecting more than 200'000 adults in the USA [2]. It causes significant pain and disability and has a tremendous impact on the patient's daily life. It is therefore crucial to identify the best treatment option for each patient individually. However, it is a challenging task to diagnose and treat patients adequately. Ideally, patients can be selected for specific treatment interventions by identifying prognostic indicators that are relevant for the course of the disease and can be modified through targeted treatment interventions. Clinicians and patients seek for a causal explanation for pain and disability. Therefore, imaging studies such as Magnetic Resonance Imaging (MRI)-findings are used to identify the pathoanatomical location that may cause the complaints. MRI is the most non-invasive used method to establish the diagnosis of LSS and findings on MRIs are believed to be causally associated with the symptoms patient's experience.

First: We showed that, despite the frequent use of MRI studies and a multidisciplinary effort to define radiological parameters relevant for the diagnosis, no association between the parameters and the pain could be identified. To date, it is not clear which somatic anomalies are causal for the clinical manifestations of the illness. In some patients the diagnosis of LSS is straightforward; these patients present themselves with the typical symptoms of "neurogenic claudication" (pain in buttocks and/or legs provoked by walking or standing and relieved by sitting and bending forward) with a single-level, localized narrowing of the lumbar canal. Symptoms, in particular the combination of symptoms, of LSS are often variable and vague what complicates the diagnosis and consequently the adequate treatment. Stenotic changes in the MRI can be also seen in asymptomatic patients,

and in patients with multilocular or multilevel stenoses it is not clear which radiological findings are causal for the symptoms.

Our findings are of great importance for patients and clinicians. It is in fact difficult to decide which level of a lumbar stenosis the surgeon needs to decompress to relief patients from their complaints. Our results also explain why, even though findings on MRI studies are believed to be relevant, a substantial proportion of patients do not improve after surgery. Despite the uncertainties, the number of surgical procedures – besides conservative treatment as a first line approach – performed for degenerative LSS has increased steadily over the years with costs reaching USD 1.65 billion per year [3]. LSS is the most frequent indication for spine surgery in patients older than 65 years of age [4]. However, the benefit of the surgery varies widely and one third of patients report no clinically relevant improvement after surgery [5, 6]. Consequently, the identification of morphological, clinical and psychological prognostic indicators is of great importance and may help clinicians in the choice to individualize treatments.

Second: Studies investigating surgical treatment option in patients with lumbar spinal stenosis provide limited arguments that support an overall framework for the choice of surgical treatment options. Based on our systematic summary of arguments for or against specific surgical procedures a conceptual framework can be postulated that needs to be investigated in future studies. Decompression surgery alone – in particular using minimal invasive approaches – is less invasive but may result in instability, spondylolisthesis and therefore, in higher reoperation rate. In contrast, fusion – with or without instrumentation – results in longer duration of the surgery, more blood loss and longer hospital stay.

Third: Clinical prognostic indicators may help to identify specific subgroups of patients that benefit from personalized treatment approaches. Despite the evidence from other studies in back pain, we found no evidence that obesity should influence the treatment decision in patients with lumbar spinal stenosis. Psychological indicators have been recognized to influence the individual coping strategies in pain. Our study is the first that assessed the causal association between fear avoidance beliefs and treatment outcome in lumbar spinal stenosis. We demonstrate that postsurgical high fear avoidance beliefs –

beliefs that may be modified by specific interventions – were associated with worse treatment outcome.

Target groups

Clinicians

Several findings of our studies are of high relevance for primary care physicians, rheumatologists and surgeons. To date, MRI studies do not help to identify the level or relevance of a lumbar spinal stenosis. We were not able to identify a correlation between pain and MRI findings. Therefore, the treatment decision needs to be based on the clinical findings and the patient's preference. Our studies on other prognostic indicators are also important for rheumatologists and surgeons, specialized in spine surgery and caring for patients with lumbar spinal stenosis. Despite being obese, patients benefited equally from surgery than lean patients. Fear of movement has been shown to be an important prognostic indicator in back pain studies. Although our study showed that preoperative fear may be because of the pending treatment decision / surgery we found persistent fear avoidance beliefs after six months to be associated with worse treatment outcome. Therefore, fear avoidance beliefs should be assessed after surgery and specific treatment should be implemented.

The findings are to some degree also relevant for general practitioners (GPs). Depending on the organization of the health care system GP's care for patients with lumbar spinal stenosis and their recommendations may also influence the patients' decision about the most appropriate treatment.

Researchers

Our findings provided useful information to researchers on how to deal with a great amount of MRI data as well as their analysis. Consequently, sophisticated statistical methods like machine learning approaches should be applied to learn more about the causal relationship between radiological findings and the patients' pain related

complaints. Furthermore, researchers should consider other imaging procedures like axial loading or upright MRI as standard MRI methods in patients with LSS.

As a consequence of our surgical framework researchers should investigate long-term outcomes of the drawbacks of decompression surgery alone in relation to instability and reoperation rates. Furthermore, our results on the influence of pre- and postoperative fear avoidance beliefs on postoperative pain and disability should be confirmed by other researchers and in addition, specific treatment interventions should be investigated.

Patients

Our findings are of great importance for patients. Treatments in LSS are preference sensitive and therefore, highly dependent on patient education and preference. Patients with lumbar spinal stenosis need to be informed that the MRI studies only poorly correlate with their specific symptoms.

Activities

The results of the studies presented in this dissertation have led to several activities in the field:

We were able to present our results on the impact of obesity on the outcome of decompression surgery (Chapter 4) at the 67th annual meeting of the German Society of Neurosurgery (DGNC) where experts (clinicians and researchers) in the fields of neurosurgery and neuro-oncology took part [7]. The subject obesity is highly topical demonstrated by the fact that we were the winner of the poster prize (out of over 130).

We also intensified the collaboration with the Institute for Machine Learning at the Swiss Federal Institute of Technology in Zurich (ETHZ), one of the top ten leading universities worldwide, to explore associations between MRI-findings and clinical parameters by applying more sophisticated statistical methods like machine learning approaches or model averaging. Furthermore, we also aim to build an automated computer based sup-

port system to identify the stenosis underlying the symptoms of the patient. First results will be expected in 2017.

The results of our systematic appraisal investigating the selection of a specific type of operation for surgical treatment of lumbar spinal stenosis (Chapter 3) influenced the research of the LSOS study group using own data; the aim of the new study (currently under review) was to assess which surgical management – decompression alone or decompression plus fusion – provides better outcome in patients with symptomatic lumbar spinal stenosis with or without spondylolisthesis.

Our findings are regularly reported in Continuing Medical Education (CME) meetings in various hospitals and medical institutions in Switzerland.

Innovation

The findings presented in this thesis are innovative in the following regards:

First: The results on the association between magnetic resonance imaging parameters and pain led to new projects that use – in the field of LSS – quite new approaches like machine learning methods to identify possible interrelationships. Furthermore, innovative automated computer based support systems will be built to identify the stenosis underlying the symptoms of the patient.

Second: We will contribute crucial and previously unknown insights about the importance of the fear avoidance model in patients with LSS thank to our findings of fear avoidance beliefs on pre- and postoperative pain and disability.

Implementation

The knowledge we have gained from this thesis will have an impact in the development of the prognostic model. The LSOS study aims to derive and validate a prognostic model to estimate the probability of clinically relevant improvement, conditional on the treatment

[6]. The model will support clinicians in estimating the expected course of the illness and consequently in recommending patients the optimal treatment.

Furthermore, the results and the insights gained from the study of Chapter 2 will be implemented in the new project we conduct together with the ETHZ and other international collaborators.

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