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Clinical pain research

Symptoms and signs possibly indicating segmental, discogenic pain. A fusion study with 18 years of follow-up

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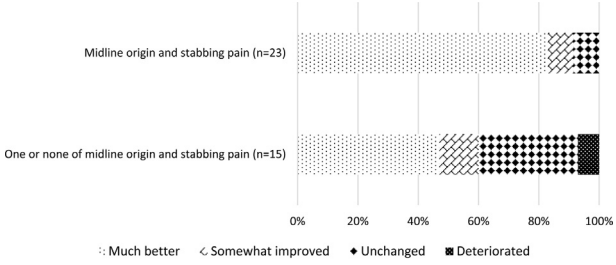
HIGHLIGHTS

- Specified symptoms related to a painful segment/disc are not previously reported.
- We analysed symptoms of patients with back pain relief following fusion operation.
- A symptom triad emerged: dominating aching midline pain, stabbing at sudden movements.
- Most patients also had diffuse leg pain radiation and often bladder frequency.
- Our results may improve selection of patients suitable for fusion surgery.

GRAPHICAL ABSTRACT



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ABSTRACT

Background: Only two out of the five existing randomized studies have reported better results from fusion surgery for chronic low back pain (CLBP) compared to conservative treatment. In these studies the back symptoms of the patients were described simply as "chronic low back pain". One possible reason for the modest results of surgery is the lack of a description of specified symptoms that might be related to a painful segment/disc, and patient selection may therefore be more or less a matter of chance. Previous prospective studies including facet joint injections and discography and eventually MRI have failed to identify patients with a painful segment/disc that will benefit from fusion surgery.
Purpose: Our purpose was to analyse in detail the pre-operative symptoms and signs presented by patients who showed substantial relief from their back pain following spinal fusion surgery with the aim of possibly finding a pain pattern indicating segmental, discogenic pain.
Methods: We analysed 40 consecutive patients, mean age 41 years, with a history of disabling low back pain for a mean of 7.7 years. Before surgery the patients completed a detailed questionnaire concerning various aspects of their back pain, and findings at clinical examination were thoroughly noted. Monosegmental posterior lumbar interbody fusion without internal fixation was performed using microsurgical technique. Outcome was assessed at 1, 2 and 4 years after surgery and finally at 18 years, using self-reporting measures and assessment by an independent examiner. Assessment at 18 years applied the Balanced Inventory for Spinal Disorders Questionnaire and the Roland-Morris Disability Questionnaire.
Results: According to the independent observer's assessment at two years 27 of the 40 patients were much improved. Analysis of the pre-operative depiction of the back symptoms of this group revealed a rather uniform pattern, the most important being: dominating back pain originating in the midline of the

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spine, with a dull, aching character and stabbing pain in the same area provoked by sudden movements. Most patients in this group also had diffuse pain radiation of various extension down one or both legs and often bladder dysfunction with frequency. At clinical examination, localized interspinal tenderness was observed within the spinal area in question and the patient's back pain was provoked by pressure in that area and by tapping a neighbouring spinous process.
At 18 years after surgery 19 patients assessed themselves as much improved. At that time 5 of them had pension due to age, 7 early pension, one worked full time and six patients part time. Eleven patients were re-operated due to defect bony healing.
Conclusions: The results may suggest that the use of a detailed symptom analysis and clinical examination may make it possible to select a subgroup of patients within the CLBP group likely to have better outcome following fusion surgery.
Implications: The next step would be to execute prospective studies and if our findings concerning back pain details and signs among CLPB patients can be confirmed this can provide for more accurate selection of patients suitable for fusion surgery.

1. Introduction

The clinical situation in patients with chronic low back pain (CLBP) varies considerably, from minor distress to total disablement. In more severe cases the demand for therapy is pressing both for the patient and the physician. For most patients with persistent unspecific pain for months and even years, a large number of non-specific treatments are proposed. Although some patients may benefit to an acceptable degree from these measures, many still experience unbearable pain after having tried all conservative methods, including psychological treatment. In such situations the possible value of spinal fusion may be discussed. However, only two out of five randomized studies have reported the results following fusion surgery for CLBP to be better than after conservative treatment [1–5]. One possible reason for the modest results of fusion surgery is the lack of a description of specified symptoms that might be related to a painful segment/disc, making patient selection more or less a matter of chance [6]. In the randomized studies mentioned above, the patients' back symptoms were described simply as "chronic low back pain" in three of the studies [2–4], as "back pain more pronounced than leg pain and no signs of nerve root compression" in the forth study [1], and as "low back pain" in the fifth study [5].

Our intention was to analyse in more detail the clinical symptoms and signs presented pre-operatively by those patients within the CLBP group who showed substantial relief from their back pain following fusion surgery, with the aim of possibly finding a pain pattern indicating segmental, discogenic pain.

2. Material and methods

2.1. Number of patients and pain duration

The material includes 40 consecutive patients, 35 women and 5 men, mean age 41 years (range 24–61), with a history of disabling low back pain for a mean of 7.7 years (range 2–36). All 40 patients were on sick leave and had been so for a mean of 4.0 years (range 1–15). All attempts at using conservative treatment methods, including long periods of physical therapy, had been unsuccessful.

2.2. Patient selection

Our intention was to find patients with symptoms from a presumed painful disc. According to our previous clinical experience, patients with more centrally located back pain had often reported a good outcome following fusion surgery. We therefore selected patients describing their back pain as located in proximity of the spine, and not in larger areas. Some, but not all of the patients had diffuse non-radicular pain radiation of varying extension down one or both legs. All patients were carefully examined radiologically by plain X-ray, CT scan or MRI in order to exclude those with specific reasons for their pain, e.g. disc herniation, stenosis, spondylolisthesis, etc.

2.3. Surgical procedure

All patients underwent monosegmental fusion without internal fixation. The presumptive painful level was chosen according to the signs at clinical examination and the results from intradiscal injection of local anaesthetic in at least two discs, blinded for the patients. Operations were performed regardless of whether or not various degenerative findings were present radiologically, and regardless of previous surgery or minor psycho-social problems. Posterior lumbar interbody fusion (PLIF) was performed using microsurgical technique. The operations were carried out between November 1987 and June 1988. Surgibone (calf bone) was used as transplant, which at that time was said to be equally effective as autologous bone [7,8]. Two patients underwent surgery at the L3–L4 level, 15 at the L4–L5 level and 23 at the L5–S1 level.

2.4. Questionnaire concerning symptoms

Before surgery all 40 patients completed a detailed questionnaire concerning various aspects of their symptoms, Table 1. The responses of those patients who showed much improvement at the 2-year follow-up, according to their own assessments and that of the independent examiner (see below), were analysed in order to determine if there was a pattern of symptoms indicating segmental, discogenic pain. These patients were also compared with those who did not show improvement following the operation.

2.5. Evaluation of outcome

In addition to the global assessments made by the patients, outcome was evaluated retrospectively by an independent observer (neurologist Henrik Weber (HW), Oslo, Norway). He also checked the list of names in the operation record during the period in question, ensuring that the patients had been operated on consecutively. The pre-operative state of the patients was recorded based on data from the hospital records and was confirmed by means of the patients' own report, including duration of pain, drug consumption, pain-provoking and alleviating factors, psycho-social state and the effect of conservative therapy. The patients were asked by HW to

Table 1
Questionnaire concerning your back problems. (Circle the alternative(s) that are true for you.).

1. How long have you had your back pain? . . . .
2. How did it start?
   (A) Suddenly, by (1) lifting, (2) an accident, (3) digging, (4) stumbling, (5) other . . . .
   (B) Insidiously
   (C) In connection with pregnancy
   (D) Other . . . .
3. I have pain (A) only in my back, (B) only in my leg/s, (C) in both my back and my legs, (D) in my back and pelvis.
4. The character of my back pain is: (A) aching, (B) smarting, (C) burning, (D) stabbing, (E) pulsating.
5. I feel that my back pain starts (A) in a small defined area, (B) in a large area, (C) in the middle of my back, the spine, (D) on the sides of my back.
6. On a scale of 1 to 4, grade the situations that provokes your back pain most, next most, etc., with 1 indicating most.
   (A) sitting, (B) standing still, (C) walking, (D) lying down.
7. What happens to your back pain if you suddenly stumble, miss a step, cough or sneeze, etc.?
   (A) no change, (B) sudden increase in back pain, (C) other.
8. If you drive your car on a bumpy road, how does that affect your back pain?
   (A) no change, (B) increased pain afterwards, (C) I feel every vibration in my back.
9. What happens to your back pain when
   (A) you bend forward? It (1) increases, (2) decreases, (3) there is no change.
   (B) you bend backwards? It (1) increases, (2) decreases, (3) there is no change.
10. When is the best time during the day concerning your back pain?
    (A) morning, (B) daytime, (C) evening, (D) during the night, (E) never.
11. If you have increased back pain after activity, what is the best way to relieve your pain?
    (A) lying down: (1) on my side, (2) on my side in a foetal position, (3) supine with straight legs, (4) supine with flexed legs, (5) prone
    (B) sitting
    (C) bending forward, for example over a table
    (D) standing
    (E) walking around
12. Mark on the line below your usual level of back pain. 0 means no pain and 100 unbearable pain.
    0---100
13. For women, how is your back pain when you are menstruating?
    (A) increased, (B) decreased, (C) unchanged, (D) I don't menstruate.
14. How far does the pain in your leg/s extend?
    (A) buttock, (B) thigh, (C) calf, (D) foot, (D) toes.
15. Describe the character of your leg pain
    (A) aching, (B) smarting, (C) burning, (D) stabbing/shooting, (E) other
16. Do you have sensations other than pain in your leg/s?
    Yes: (A) numbness, (B) tingling, (C) pricking, (D) pins and needles, (E) sensation of warmth/cold
    No
17. Mark on the line below your usual level of leg pain. 0 means no pain and 100 unbearable pain.
    0---100
18. How is your bladder function?
    (A) normal, (B) have frequency/urgency, (C) incontinence, (D) dribbling

describe the state of their spine pre- as well as post-operatively by using one of the following expressions: *good*, *rather good*, *fair*, *inferior*, *poor* or *miserable*.

In order to create an "over-all" assessment, four factors were assessed, scored using a VAS scale and summarized numerically by HW. These comprised: (a) the consumption of analgesics; (b) the history of illness, signs and symptoms of the patient including the mobility and state of the spine, neurological deficits, and function of the urinary bladder; (c) back pain intensity (VAS 0–100); and (d) results of the Roland-Morris Disability Questionnaire reduced from 24 to 20 questions. According to the degree of severity regarding factors a and b, respectively, HW marked a point on a VAS scale. Similarly, the functional state of the patient as recorded by the Roland-Morris Questionnaire was transformed to a VAS scale according to the number of positive answers. The VAS scores for factors b, c and d were regarded by HW as being more reliable in describing the disability state of the patient, and these values were therefore multiplied by three. The total sum of all four values constituted the "over-all" assessment. Differences between pre- and post-operative values were classified by HW as follows: much improved (50–100% improvement), somewhat improved (20–49%), unchanged (±19%) or deteriorated (less than −19%).

All patients were examined by HW at one year after surgery. At two years 34 patients were examined and four were interviewed by telephone. At that time one patient had been diagnosed as having breast cancer with spinal metastases that induced new symptoms, and was therefore excluded. Another patient did not participate. At 4 years 15 patients were examined by HW and 23 were interviewed by telephone. At follow-up the patients were asked for their own opinions regarding the effect of the operation using one of the following descriptions: *much improved*, *somewhat improved*, *unchanged* or *deteriorated*.

The patients underwent a final follow-up 18 years post-operatively that comprised a questionnaire, the Balanced Inventory for Spinal Disorders, BIS [9–11], including assessment of their back and leg pain, their physical, social and mental condition, use of analgesics, work situation, and a general statement concerning whether their current situation was *much better*, *somewhat better*, *unchanged*, *somewhat worse* or *much worse* compared with the situation before surgery.

2.6. Pre-operative clinical examination

The clinical examination included inspection of posture, whether kyphosis or exaggerated lordosis was present, the patient's ability to perform flexion and extension of the lumbar spine, and a routine neurological examination including motor, sensory and reflex analysis. Interspinal palpation of the lumbar spine was performed and any distinct interspinal tenderness was noted. A tapping test was developed and performed with the patient lying on his/her side in a slight foetal position. The base of a tuning fork was placed against the respective spinal process and tapped in a longitudinal direction, thereby producing a percussion of the respective process, and the reaction of the patient was noted.

Table 2
The patients' descriptions of their back situation pre-operatively and at 1, 2 and 4 years after surgery (number of patients).

	Pre-op	1 year	2 years	4 years
Good	0	13	17	14
Acceptable	0	10	6	7
Fair	0	4	5	5
Inferior	1	5	4	5
Poor	11	3	0	4
Miserable	28	5	6	3
	40	40	38	38

2.7. Post-operative radiological examination

Bony healing was studied by plain X-ray at 4, 8, 12 and 18 months post-operatively which in some cases did not allow for assessment of complete bony healing. In these cases CT scans using 1-mm-thick sections with reformation in sagittal and frontal planes were performed [12,13].

2.8. Previous surgery

Prior to treatment at our clinic, 13 of the 40 patients had undergone surgical procedures for their back problems. Seven patients had undergone a decompression procedure, one patient a decompression and fusion, four patients had had three previous operations each, and one patient had undergone five operations including decompression and fusion procedures. Altogether, the 13 patients had undergone 26 previous operations.

3. Results

3.1. Clinical results

The patients' own opinions regarding their clinical situation before operation and at 1, 2 and 4 years post-operatively are shown in Table 2. The patients' opinions regarding changes in their clinical condition at 1, 2 and 4 years post-operatively are shown in Table 3 in comparison with the opinions of HW.

At 18 years after surgery 19 patients assessed their back pain to be *completely disappeared* or *much better* than before surgery, eight patients as *somewhat better*, two as *unchanged*, three as *somewhat worse* and three as *much worse*. Three patients did not respond.

At 2 years after surgery 27 of the patients were much improved according to HW's assessment (Table 3). These patients then comprise a group in which pre-operative symptoms and clinical signs may be analysed with the aim of possibly revealing symptoms and signs of prognostic significance. This "good outcome group" consisted of 23 women and 4 men, mean age 41 years. They had had on average 6.7 years of back pain and had been on sick leave on average 3.5 years before the operation.

At the 2-years follow-up 6 patients were assessed by HW as unchanged and one as deteriorated (Table 3). The symptoms of these seven patients (the "poor outcome group") were then compared with those in the "good outcome group". Another four patients were somewhat better at 2 years and, for clarity, were not analysed further.

Table 3
The opinions of the patients and of the independent observer (HW), concerning change in the patient's back symptoms at 1, 2 and 4 years after surgery (number of patients).

	1 year		2 years		4 years	
	HW	Pat	HW	Pat	HW	Pat
Much better (50–100%)	26	25	27	26	22	24
Somewhat better (20–49%)	6	8	4	4	9	7
Unchanged (±19%)	8	4	6	7	6	6
Worse (>−19%)	0	3	1	1	1	1
	40	40	38	38	38	38

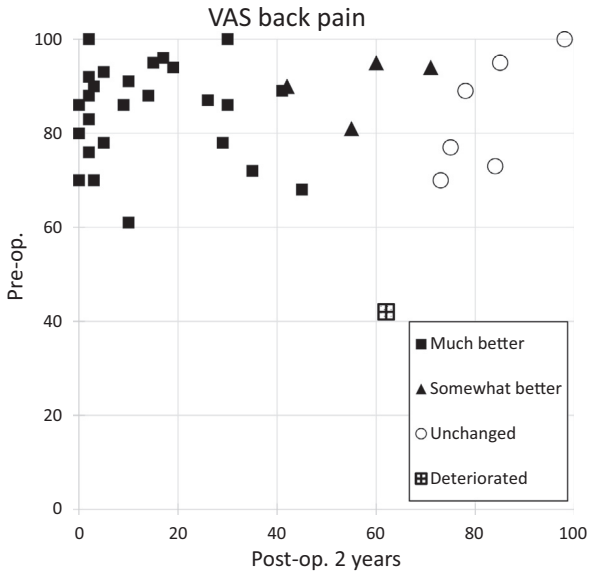

Fig. 1. The paired pre- and 2-years postoperative back pain VAS values for each individual patient are plotted. The patient classification according to the independent examiner is denoted by the different symbols.

3.1.1. Back pain, VAS

The VAS values for back pain of each patient prior to surgery and at 2 years after surgery are plotted in Fig. 1. At 18 years after surgery the back pain VAS in the "good outcome group" (see below) was 15 (median) and in the "poor outcome group" (see below) 80 (median).

3.1.2. Functional state

The functional state of the patients as reflected by the Roland-Morris Questionnaire before and up to 18 years post-operatively is shown in Fig. 2.

3.1.3. Sick leave

Before surgery all 40 patients were on sick leave and had been so for a mean of 4.0 years. At two years after surgery the independent examiner (HW) noted 16 patients to be in full work and a further 5 patients to work part time, all these patients belonging to the "good outcome group" (see below).

Among the 19 patients assessing themselves as *much better* at 18 years (see Section 3.1) 5 patients had pension due to age and 7 early pension, one patient worked full time and 6 patients part time.

3.1.4. Medical consumption

The independent examiner (HW) categorized the patients' use of analgesics as: overuse, maximal use, moderate, slight or no use. Before surgery the number of patients in the respective levels were 12, 10, 8, 8 and 2. At two years after surgery the respective figures were 1, 6, 2, 4 and 25.

3.2. Analysis of pre-operative symptoms

3.2.1. Analysis of patient groups resulting from the independent examiners assessment

3.2.1.1. The "good outcome group". When analysing the patients' responses to the questionnaire that was filled in at the time of the

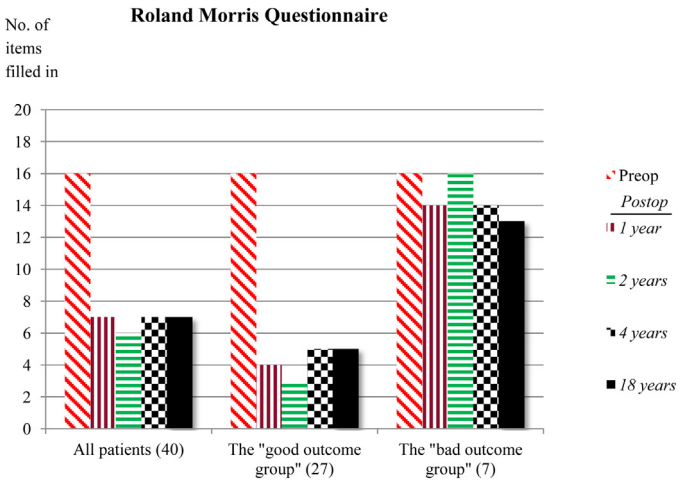

Fig. 2. The functional state of the patients as reflected by the Roland-Morris Questionnaire, reduced from 24 to 20 items. Concerning the reason for reducing the number of items, see text. Item nr 12 "I find it difficult to get out of a chair because of my back" omitted, being similar to nr 7 "Because of my back, I have to hold on to something to get out of an easy chair". Nr 19 omitted, "Because of my back pain, I get dressed with help from someone else", being similar to nr 8 "Because of my back, I try to get other people to do things for me". Nr 21 omitted "I avoid heavy jobs around the house because of my back", being similar to nr 4 "Because of my back I am not doing any of the jobs that I normally do around the house". Nr 23 omitted, "Because of my back, I go upstairs more slowly than usual", being similar to nr 3 and 5, "I walk more slowly than usual because of my back" and "Because of my back, I use a handrail to get upstairs".

operation (Table 1), it emerged that 23 of the 27 patients in the "good outcome group" had reported a sudden onset of back pain, 25 patients had pain in both their back and their legs, with diffuse localization of the leg pain suggesting referred pain. The origin of the back pain was felt to be in the midline of the spine by 24 of the 27 patients, whereas three patients felt back pain in a larger area. The character of the back pain was dull and aching in 26 of the 27 patients, and 23 patients also had a stabbing, knife-like pain, also in the midline, in connection with an abrupt side step, stumbling, coughing or sneezing, and 23 experienced such pain when driving on a bumpy road. The dull, aching pain was provoked most by sitting and standing, while walking felt reasonably good, and lying down, often in a specially chosen favourite position, felt best. Regarding their back pain, the best time of day was in the morning (16 patients), and the best position for relief of the back pain was lying on their side in a slight foetal position (19 patients).

Pain radiating down the legs was found in 25 of the 27 patients; 11 had radiation in both legs, seven in the right leg and seven in the left leg. The radiation was diffuse, pseudoradicular and extended to the toes in 23 of the 27 patients. There was no dermatomal pattern in the leg pain distribution to indicate which segment was responsible for the pain (Fig. 3). The character of the leg pain was mostly aching (18 patients), but shooting sensations were also common (10 patients). Subjective numbness was very common (25 patients), but tingling (13 patients) and the sensations of pins-and-needles also occurred (13 patients). A majority of the

Leg pain radiation, dermatomal type

Fusion level	Number of pat.	L5 type	L5 +S1 mixed type	S1 type	No radiation
L3-4	1	-	1	-	-
L4-5	10	3	4	2	1
L5-S1	16	2	7	6	1

Fig. 3. Dermatomal type of leg pain distribution in relation to the disc that is probably responsible.

patients also described bladder dysfunction, generally symptoms of frequency (17 patients).

3.2.1.2. The "poor outcome group". Patients belonging to the "poor outcome group" did not differ from the patients in the "good outcome group" with respect to the character of the back pain, its being provoked mostly by sitting and standing, and morning being the best time of day. These patients also had diffuse leg pain extending to the toes and five had bladder dysfunction with frequency. However, only three had had a sudden onset of their back pain. The most obvious difference seen between the groups was the origin of the back pain reported by the patients. Among the seven in the "poor outcome group" only two localized it to the midline compared to 24 of the 27 patients in the "good outcome group".

3.2.2. Pre-operative symptoms of prognostic value

When various pre-operative symptoms were analysed and related to the patients' paired assessments of perceived back pain situation at study start and on the follow-up occasion two years after surgery, two specified symptoms clearly emerged; (a) the patient's report of back pain origin in the midline of the spine and (b) the presence of stabbing pain upon sudden movements. Among the 23 patients reporting both these symptoms 18 assessed their back situation two years after surgery to be good (8+5) or rather good (4+1), altogether 78% (Fig. 4A), whereas among those reporting only one or lacking these symptoms 5 out of 15 patients assessed their back situation as good (2+2) or rather good (1), together 33% (Fig. 4B), a statistically significant difference ($\chi^2 = 7.67$, $p < 0.01$). Among the 23 patients reporting both midline origin of the back pain and presence of stabbing pain at sudden movements, 21 assessed themselves as improved two years after surgery (Fig. 5) as against 9 out of 15 among those with one or none of these symptoms (Fig. 5). The difference between the groups is statistically significant ($\chi^2 = 5.35$, $p < 0.05$).

Among the patients who had a sudden onset of their back problems 68% belonged to the good/rather good group at 2 years against 40% among those without a sudden onset (no statistically significant difference). Various other back symptom details, the presence and various extension of leg pain or the presence or not of bladder disturbance did not show prognostic significance.

3.3. Pre-operative clinical signs

Most of the 27 patients with a good outcome had normal posture, although 10 showed slight lumbar kyphosis. Muscle tenderness was not an outstanding sign. The back pain was aggravated upon bending backwards while standing in 20 of the 27 patients compared to only two patients when bending forward, and five patients when bending both backwards and forward. There were no motor or sensory disturbances and no reflex abnormalities. A true Lasegue sign was never present. Interspinal tenderness was found at the level later chosen for fusion in 16 patients and at an adjacent level in 10 patients, and it differed by two levels in one patient. Pressure in the area of interspinal tenderness provoked the deep back pain. All 27 patients in the "good outcome group" showed sensitivity to the tapping test around the suspected pain origin, and this test also provoked the deep back pain.

3.4. Complications

Up until the 2-year follow-up, eleven of the patients were re-operated due to defective bony healing, six of them belonging to the "good outcome group" and thus showing a good outcome after re-operation. Five of the seven patients in the "bad outcome group" were re-operated but without improvement.

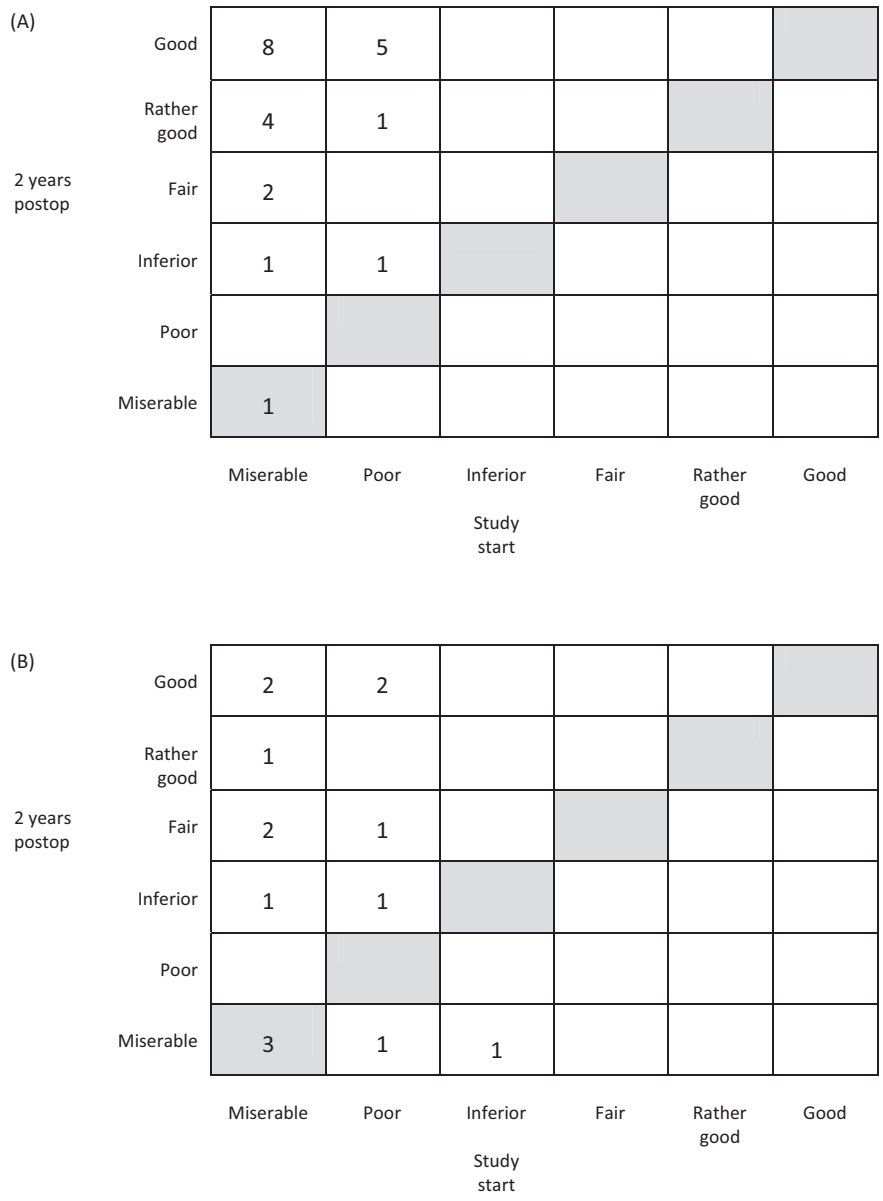

Fig. 4. The frequency distribution of the pairs of assessments of perceived back pain situation made by the patients at study start and on the follow-up occasion two years after surgery, for patients reporting midline origin of their back pain and also stabbing midline pain (A) and patients with only one of or lacking these symptoms (B).

	Midline origin and stabbing pain	One or none of midline origin and stabbing pain
Much improved	19	7
Somewhat improved	2	2
Unchanged	2	5
Deteriorated	0	1
	23	15

Fig. 5. Number of patients assessing their respective change in clinical situation at the 2-years follow-up. Comparison between patients reporting back pain origin in the midline and also stabbing pain and patients with only one of or lacking these symptoms.

4. Discussion

We have previously discussed the need for a better analysis and description of the symptoms that might indicate a painful segment/disc [6]. The present study is an attempt in that direction despite some weaknesses, one being the retrospective analysis of outcome although the symptoms and signs were recorded pre-operatively. The independent observer, Henrik Weber, was, however, an experienced researcher [14,15] and was well aware of the difficulties concerning assessments of clinical outcome. Further, his assessments were in good accord with the patients' own opinion concerning the effect of surgery (Table 3). It is previously found that the patients' global assessment is a valid description of the overall effect of treatment for CLBP [16]. At two years after surgery 27 of our patients assessed themselves as much better, so also the independent examiner, this improvement being fairly stable also for as long as 18 years. Whether this change is causal to surgery or not cannot be decided from this our pilot study, but the change is real and these patients therefore worth studying concerning pre-operative symptoms of possible prognostic importance.

Few previous studies have dealt with symptoms and signs that might be related more specifically to a painful disc. This state, discogenic pain, is reported by some to be reliably revealed by concordant pain reaction at discography [17–21], but others are in disagreement [22–24]. When using this test procedure Schwarzer

et al. [19] were unable to differentiate patients with discogenic pain clinically from other patients within the CLBP population. In contrast to our findings, they found that patients with central lumbar pain were unlikely to suffer from discogenic pain. Young et al. [25], who also used concordant pain reaction at discography as an indicator of a painful disc, described centralization of back pain during repeated testing and pain when rising from sitting as symptoms related to a painful disc. Contrary to our findings Ohnmeiss et al. [26] described specific pain projection areas in the leg/s during discography as shown in pain drawings, as being related to specified lumbar discs (see Fig. 3). They also described discogenic pain as being mainly burning in character, which also contrasts to our findings. The only previous study describing many of the symptoms and signs we found in our CLBP patients who improved by fusion surgery is that of Lettin [27], published more than 40 years ago. He also described a sudden onset of the back pain in his patients, increasing pain when standing and sitting, aggravated pain (but not stabbing) while coughing and sneezing, pain and paraesthesia in the legs, and midline tenderness.

Logically, provocative discography would be the most suitable test for pinpointing a painful disc, and several reports defend this opinion [17–21,28–31] while others do not [22–24,31,32]. In fusion surgery in patients suffering from non-specific CLBP Madan et al. [22] and Carragee et al. [23] did not find pain reaction at discography to be a reliable method for pinpointing a presumed painful disc. However, if a more homogeneous population of patients within the CLBP group could be selected, truly representing patients with discogenic pain, the pain reaction at discography might be a possible selection instrument for indication of the proper disc. At present there is no validated method for pinpointing a painful disc [33,34]. The discoblock we used has been compared with the pain reaction at discography and found to be a better selection instrument [35], although it is not validated. Nor has the use of temporary external fixation proven to be of value for selecting the proper disc [36]. It could therefore be said that the method we used, discoblock, may be as good or as bad as any other method.

If a model patient representing segmental, discogenic pain were to be established based on our analysis of the preoperative symptoms and signs of the patients showing much improvement 2 years after surgery, the most important would be: back pain originating in the midline of the spine, being aching in character, with provocation of stabbing pain in the same area with sudden movements. Besides, in most patients the back pain should be combined with diffuse pain radiation down one or both legs, even to the toes, often with paraesthesia and also bladder dysfunction with frequency.

Our observation in the present study that CLBP patients showing a good outcome two years after fusion surgery present with a fairly uniform pattern of symptoms and signs does not rule out the possibility that patients with divergent symptoms and signs may also benefit from a fusion operation. This, however, must then be analysed in a similar way.

One weakness of our study is the use of Surgibone (calf bone) as transplant without internal fixation. This resulted in many cases of defective bony healing. Re-operation of patients in the "good outcome group" using autologous bone resulted in bony healing, and most of these patients had a good outcome. Patients in the "poor outcome group" who were subjected to re-operations without success differed somewhat from the "good outcome group" regarding their back symptoms. There may have been reasons other than discogenic pain for their complaints, alternative, segment selection may have been wrong.

5. Conclusions

Patients within the CLBP group reporting (1) back pain origin in the midline and (2) with provocation of stabbing pain in that area at sudden movements, and also (3) showing localized interspinal tenderness in the same area with provocation of the deep back pain by pressure and by tapping a neighbouring spinous process, may benefit from fusion surgery. Our results are previously described in a preliminary report [37].

Conflict of interest

The authors have no conflict of interest.

Ethical issues

The patients gave their informed consent to the study. Ethical Boards did not exist at the time this study was undertaken.

References

[1] Fritzell P, Hägg O, Wessberg P, Nordwall A. 2001 Volvo award winner in clinical studies: lumbar fusion versus nonsurgical treatment for chronic low back pain. Spine 2001;26:2521–34.
[2] Brox JI, Sörensen R, Friis A, Nygaard Ö, Indahl A, Keller A, Ingebrigtsen T, Eriksen H, Holm I, Koller AK, Riise R, Reikerås O. Randomized clinical trial of lumbar instrumented fusion and cognitive intervention and exercises in patients with chronic low back pain and disc degeneration. Spine 2003;28:1913–21.
[3] Fairbank J, Frost H, Wilson-MacDonald J, Yu L-M, Barker K, Collins R. Randomised controlled trial to compare surgical stabilisation of the lumbar spine with an intensive rehabilitation programme for patients with chronic low back pain: the MRC spine stabilisation trial. BMJ 2005;330:1233–9.
[4] Brox JI, Reikerås O, Nygaard Ö, Sörensen R, Indahl A, Holm I, Keller A, Ingebrigtsen T, Grundnes O, Lange JE, Friis A. Lumbar instrumented fusion compared with cognitive intervention and exercises in patients with chronic back pain after previous surgery for disc herniation: a prospective randomized controlled study. Pain 2006;122:145–55.
[5] Ohtori S, Koshi T, Yamashita M, Yamashita M, Yamauchi K, Inoue G, Suzuki M, Orita S, Eguchi Y, Ochiai N, Kishida S, Takaso M, Kuniyoshi K, Aoki Y, Ishikawa T, Arai G, Miyagi M, Kamoda H, Suzuki M, Nakamura J, Toyone T, Takahashi K. Surgical versus nonsurgical treatment of selected patients with discogenic low back pain. Spine 2011;36:347–54.
[6] Nyström B. Spinal fusion in the treatment of chronic low back pain: rationale for improvement. Open Orthop J 2012;6:478–81.
[7] Taheri ZE, Gueramy M. Experience with calf bone in cervical interbody spinal fusion. J Neurosurg 1972;36:67–71.
[8] Siqueria EB, Kranzler LI. Cervical interbody fusion using calf bone. Surg Neurol 1982;18:37–9.
[9] Svensson E, Schillberg B, Kling A-M, Nyström B. The balanced inventory for spinal disorders. The validity of a disease specific questionnaire for evaluation of outcomes in patients with various spinal disorders. Spine 2009;34:1976–83.
[10] Svensson E, Schillberg B, Kling A-M, Nyström B. Reliability of the Balanced inventory for spinal disorders, a questionnaire for evaluation of outcomes in patients with various spinal disorders. J Spinal Disord Tech 2012;25:196–204.
[11] Svensson E, Schillberg B, Zhao X, Nyström B. Responsiveness of the Balanced Inventory for Spinal Disorders. A questionnaire for evaluation of outcomes in patients with various spinal disorders. J Spine Neurosurg 2015;4:2, http://dx.doi.org/10.4172/2325-9701.1000184.
[12] Enblom M, Hansson J, Moström U, Nyström B. Benläkningskontroll efter fusionskirurgi i ländryggen. Datortomografi med tunna snitt och låg stråldos. Swed Soc Med Radiol Förhandlingar 1995;32:76–80.
[13] Enblom M, Moström U, Hansson J, Nyström B. Assessment of fusion in the lumbar spine with thin slice low dose CT. Ups J Med Sci 1998;54(Suppl.):52–3.
[14] Weber H. Lumbar disc herniation. A controlled, prospective study with ten years of observation. Spine 1983;8:131–40.
[15] Amundsen T, Weber H, Nordal HJ, Magnaes B, Abdelnoor M, Lilleas F. Lumbar spinal stenosis: conservative or surgical management?: a prospective 10-year study. Spine 2000;25:1424–35.
[16] Hägg O, Fritzell P, Odén A, Nordwall A. Simplifying outcome measurement. Evaluation of instruments for measuring outcome after fusion surgery for chronic low back pain. Spine 2002;27:1213–22.
[17] Colhoun E, McCall IW, Williams L, Cassar Pullicino VN. Provocation discography as a guide to planning operations in the spine. J Bone Joint Surg Br 1988;70-B:267–71.
[18] Schwarzer AC, Aprill CN, Derby R, Fortin J, Kine G, Bogduk N. The relative contributions of the disc and zygapophyseal joint in chronic low back pain. Spine 1994;19:801–6.
[19] Schwarzer AC, Aprill CN, Derby R, Fortin J, Kine G, Bogduk N. The prevalence and clinical features of internal disc disruption in patients with chronic low back pain. Spine 1995;20:1878–83.
[20] Zdeblick TA. Discogenic back pain. In: Rothman RH, Simeone FA, editors. The spine. Philadelphia: WB Saunders; 1999. p. 749–65 [Chapter 28].

[21] Kallewaard JW, Terheggen MAMB, Groen GJ, Sluijter ME, Derby R, Kapural L, Mekhail N, Van Kleef M. Discogenic low back pain. Pain Pract 2010;10: 560–79.
[22] Madan S, Gundanna M, Harley JM, Boeree NR, Sampson M. Does provocative discography screening of discogenic back pain improve surgical outcome? J Spinal Disord Tech 2002;15:245–51.
[23] Carragee EJ, Lincoln T, Parmar VS, Alamin T. A gold standard evaluation of the "discogenic pain" diagnosis as determined by provocative discography. Spine 2006;31:2115–23.
[24] Hebelka H, Nilsson A, Hansson T. Pressure increase in adjacent discs during clinical discography questions the methods validity. Spine 2014;39:893–9.
[25] Young S, Aprill C, Laslett M. Correlation of clinical examination characteristics with three sources of chronic low back pain. Spine J 2003;3:460–5.
[26] Ohnmeiss DD, Vanharanta H, Ekholm J. Relation between pain location and disc pathology: a study of pain drawings and CT/Discography. Clin J Pain 1999;15:210–7.
[27] Lettin AWF. Diagnosis and treatment of lumbar instability. J Bone Joint Surg (Br) 1967;49:520–9.
[28] Simmons EH, Segil CM. An evaluation of discography in the localization of symptomatic levels in discogenic disease of the spine. Clin Orthop Relat Res 1975;108:57–69.
[29] Aprill C, Bogduk N. High-intensity zone: a diagnostic sign of painful lumbar disc on magnetic resonance imaging. Br J Radiol 1992;65:361–9.
[30] Lee CK, Vessa P, Lee JK. Chronic disabling low back pain syndrome caused by internal disc derangements. The results of disc excision and posterior lumbar interbody fusion. Spine 1995;20:356–61.
[31] Bogduk N, Modic MT. Controversy lumbar discography. Spine 1996;21: 402–4.
[32] Carragee EJ. Is lumbar discography a determinate of discogenic low back pain: provocative discography reconsidered. Curr Rev Pain 2000;4:301–8.
[33] Hancock MJ, Maher CG, Latimer J, Spindler MF, McAuley JH, Laslett M, Bogduk N. Systematic review of tests to identify the disc, SIJ or facet joint as the source of low back pain. Eur Spine J 2007;16:1539–50.
[34] Willems PC, Staal JB, Walenkamp GHIM, de Bie RA. Spinal fusion for chronic low back pain: systematic review on the accuracy of tests for patient selection. Spine J 2013;13:99–109.
[35] Ohtori S, Kinoshita T, Yamashita M, Inoue G, Yamauchi K, Kosci T, Suzuki M, Orita S, Eguchi Y, Nakamura S, Yamagata M, Takaso M, Ochiai N, Kishida S, Aoki Y, Takahashi K. Results of surgery for discogenic low back pain. A randomized study using discography versus discoblock for diagnosis. Spine 2009;34:1345–8.
[36] Elmans L, Willems PC, Anderson PG, van Limbeek J, de Kleuver M, van der Schaaf D. Temporary external transpedicular fixation of the lumbosacral spine. A prospective, longitudinal study in 330 patients. Spine 2005;30:2813–6.
[37] Nyström B. Lumbal segmentell smärta I. Anamnestiska uppgifter och kliniska fynd. Hygiea 1989;98:253.