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Pain 5 years after instrumented and non-instrumented posterolateral lumbar spinal fusion

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Abstract Pain drawings have been used in spine surgery for diagnostic use and psychological evaluation of fusion candidates; they have rarely been used to evaluate pain status after spinal fusion. This study is a 5-year follow-up on a randomised clinical trial assigning patients to posterolateral spinal fusion with or without pedicle screw instrumentation. Patients were mailed a pain drawing and questionnaires including questions regarding work, social status, smoking status, the Dallas Pain Questionnaire (DPQ), and the Low Back Pain Rating Scale (LBPRS). Pain drawings were scored using a visual inspection method and a surface-based point scoring and evaluated for the presence of donor site pain. Pain drawings from 109 patients (87% of the initially included patients), 56 men and 53 women, mean age at follow-up 51 years, were analysed. Fifty-three patients had undergone an instrumented fusion and 56 a non-instrumented fusion. Some presence of low back pain was marked by 79% and leg pain by 69%. Sixty-two percent of the pain drawings were classified as “organic” and 38% as “non-organic”. There was no difference

between the instrumented and the non-instrumented group. DPQ and LBPRS scores were higher in the non-organic group ($P=0.007$). Using the point scoring, no difference between the instrumented and the uninstrumented group was seen. The results of the point scoring were found to correlate with the DPQ and LBPRS scores ($P=0.001$). Working patients (39%) had significantly better scores than the rest. Ten percent of the patients had donor site pain. Twenty percent of spinal fusion patients are totally pain free at 5-year follow-up. Ten percent still experience donor site pain. In general, instrumentation does not affect the amount and localisation of pain 5 years after lumbar spinal fusion surgery. The pain drawing seems to be a valuable tool when following spinal fusion patients, but its use as prognostic marker in connection with fusion surgery needs further investigation.

Keywords Pain drawing · Spinal fusion · Dallas Pain Questionnaire · Low Back Pain Rating Scale · Donor site pain · Instrumentation · Randomised clinical trial

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Introduction

Posterolateral spinal fusion has become an evidence-based treatment of chronic low back pain caused by spondylolisthesis or spinal instability [12, 26]. Although widely

used, the beneficial effect on the clinical outcome of adding pedicle-screw fixation to the posterolateral spinal fusion has not yet been demonstrated [11, 13, 25, 38]. All studies have shown reduction in pain and disability, but few have investigated the severity and localisation of residual pain several years after the procedure.

Fig. 1 **A** Pain drawing classified as “organic”. This pain drawing was also classified in the group with donor site pain due to the use of the “.....” symbols in the area of the right buttock. **B** Pain drawing classified as “non-organic” and also with donor site pain, due to the use of “NNN” symbols in the area of the right buttock, which do not appear elsewhere on the lower back. **C** Pain drawing classified as “organic”; no donor site pain. The same symbols are used to mark back and radiating pain. **D** The pain drawing with the 16 areas used for the pain sites score

Pain drawings have been used in spinal surgery for psychological evaluation of patients [8, 18, 32, 40], for diagnostic purposes [5, 29, 30, 31, 33] and for prediction of outcome [15, 23, 24, 37]. Few have used the pain drawing for evaluation of pain after spinal surgery. Several methods of interpretation have been applied. For psychological evaluation, the method described by Ransford et al. [34] or modifications of it have been used [31, 32, 40]. The diagnostic value of the pain drawing is most often based on whether the pain markings correspond with relevant anatomical structures or not [3, 29, 30, 33, 39]. Also, for evaluation and quantification of pain, several surface-based methods have been applied [20, 22, 27, 30].

One type of pain, which could be speculated to be present after lumbar spinal fusion surgery, is donor site pain. The presence of donor site pain after harvest of iliac crest bone graft is well reported, although the incidence varies [2, 14, 36]. It is one of the main arguments for the use of bone graft substitutes [35].

Aim of the study

The purpose of this study was to assess the severity, type and localisation of pain 5 years after posterolateral spinal

fusion, with or without instrumentation, using pain drawings. Special attention was given to the occurrence of donor site pain. A second purpose was to correlate the scoring of the pain drawing to scores derived from the Dallas Pain Questionnaire (DPQ) and Low Back Pain Rating Scale (LBPRS).

Materials and methods

Patients

The patient population in this study comprised 130 patients randomised, as part of an earlier study, to posterolateral lumbar fusion with or without Cotrel-Dubousset pedicle screw instrumentation (CD) [9, 38]. All patients suffered at inclusion from severe chronic low back pain due to localised lumbar or lumbosacral instability caused by either isthmic spondylolisthesis grade I–II, primary degeneration (no previous surgery), or secondary or accelerating degeneration after decompressive surgery.

Of this 130, 127 patients were available for 5-year follow-up (one was excluded initially because of dysplastic pedicles, two had died of unrelated causes), and they were mailed a pain drawing and two questionnaires. Of those mailed, 111 patients responded to the pain drawing and the questionnaires, one patient responded with a refusal to participate, and one of the pain drawings was impossible to interpret, resulting in 109 patients (87%) being included in this investigation. The 109 patients comprised 56 men and 53 women;

the mean age at time of follow-up was 51 years, range 26–74 years (men: mean age 51, range 29–67 years; women: mean age 52, range 26–74 years). There was a total of 53 patients in the CD group and 56 patients in the non-CD group (CD: m/f 29/24, mean age 52, range 26–72 years; non-CD: m/f 27/29, mean age 51, range 29–74 years).

Pain drawing

The pain drawing consisted of a front and back outline of a person as well as the area under the feet (Fig. 1). The patients were asked to indicate all their pain at the present time on the drawing. Six different symbols could be used for marking pain, each denoting a different quality of pain: dull/aching, burning, numbness, pins and needles, stabbing/cutting and muscular cramps. The pain drawing took up a single side in the A4-size questionnaire.

Scoring methods

The first author (T.A.), blinded to treatment group, scored all pain drawings. The pain drawings were scored using two methods, and they were further evaluated for the presence of donor site pain.

Visual inspection method

The pain drawings were classified by visual inspection as first described by Uden et al. [40] and later used by Moller [24] into four categories: organic, possible organic, possible non-organic or non-organic. This method has been shown to have a high reproducibility and acceptable inter- and intra-observer variability [8, 24, 28, 40]. For ease of use, the organic and possible organic drawings were pooled to an “organic” group and those classified as non-organic or possible non-organic were pooled to a “non-organic” group as previously described [8, 24, 40].

Pain score

The pain drawing was divided into 16 regions (Fig. 1D), using a transparency overlay. The divisions were a modification of those used by Parker et al. [32]. One point was allocated for the presence of one or more pain symbols within each division, resulting in a score range of 0–16. As this scoring method does not include any clinical judgement, the reproducibility is high and the problem of inter- and intra-observer variability very small.

Donor site pain

Special attention was paid to the area where graft harvesting had been performed. Presence of pain markings separate from back pain markings or of different symbols in that area were used to classify the presence of donor site pain into one of the following three subjective categories: present, possibly present or not present (Fig. 1A–C).

Follow-up questionnaires

The first questionnaire consisted of a series of questions dealing with socio-demographic variables (work status, employment, ongoing compensation case, etc.), the Dallas Pain Questionnaire (DPQ), and the back and leg pain scales from the Low Back Pain Rating Scale (LBPRS). The DPQ [19] assesses the functional impact of chronic spinal pain in four categories: daily activities, work-leisure activities, anxiety-depression, and social concerns. A

high score in a category indicates that the patient’s spine problems have a high impact on the patient in that category. LBPRS [21] is an index scale that includes measurement of pain intensity ranging from 0 (no pain) to 10 (worst pain). It includes three questions regarding low back pain and three questions regarding leg pain. The second questionnaire consisted of questions about smoking habits before and after the operation as well as current smoking status [1].

Statistics

The significance of differences between groups was determined by the Mann-Whitney rank sum test, calculations with more than one variable per group were analysed using the χ^2 test. Significance of correlations were analysed using Pearson correlation. Ninety-five percent confidence intervals (two-tailed) were considered significant. SPSS version 10.0 for Windows was the software used for the statistical analysis.

Results

General pain description

There was no difference between the two groups in self-reported pain in the back or the legs (Table 1). Overall, 21% of the patients were without pain. The remaining 79% marked some presence of low back pain, mostly using the dull/aching, cutting/stabbing or burning symbols (Table 1). Fifty-five patients (50%) had used more than one symbol in marking their back pain. Seventy-five patients (69%) had marked some kind of leg pain.

Visual inspection method

Using the visual inspection method, 38 patients (35%) were classified as “organic”, 30 patients (28%) as “possible organic”, 23 (21%) as “possible non-organic” and 18 patients (17%) were classified as “non-organic”. When pooled, 62% were classified as “organic” and 38% as “non-organic”. There was no difference between the two treatment groups (38% non-organic pain drawings in each group). Female gender was, however, strongly associated with a non-organic pain drawing (25% non-organic drawings among male patients and 51% non-organic drawings among female patients, $P=0.005$).

There were significantly fewer non-organic pain drawings among patients still working compared to the rest, and also a tendency towards more non-organic pain drawings among patients who were applying for a pension due to back-related problems (Table 2). There was an overrepresentation of men among the working patients and of women among the patients applying for a pension due to back-related problems.

Seventy-five percent of patients with an organic pain drawing answered “yes” to the question: “Would you undergo the operation again now that you know the result?”, whereas this was the case for only 60% of patients with a

Table 1 Presence of the different pain types according to localisation^a and treatment group in 109 patients treated 5 years previously with posterolateral spinal fusion. Values are presented as percentages, with numbers (*n*) in parentheses

		No pain	Dull/ aching	Burning	Pins & needles	Stabbing/ cutting	Numbness	Muscular cramp	>2 sym- bols ^b
Upper back	CD	72% (38)	7% (4)	7% (4)	4% (2)	4% (2)	0% (0)	4% (2)	2% (1)
	Non-CD	77% (43)	5% (3)	5% (3)	2% (1)	9% (5)	0% (0)	2% (1)	0% (0)
Low back	CD	21% (11)	23% (12)	15% (8)	6% (3)	19% (10)	4% (2)	6% (3)	7% (4)
	Non-CD	21% (12)	27% (15)	11% (6)	11% (6)	16% (9)	4% (2)	0% (0)	11% (6)
Posterior thigh	CD	49% (26)	9% (5)	11% (6)	6% (3)	9% (5)	2% (1)	13% (7)	0% (0)
	Non-CD	55% (31)	11% (6)	4% (2)	7% (4)	9% (5)	4% (2)	9% (5)	2% (1)
Posterior lower leg	CD	57% (30)	4% (2)	2% (1)	2% (1)	6% (3)	4% (2)	23% (12)	4% (2)
	Non-CD	50% (28)	5% (3)	7% (4)	4% (2)	2% (1)	4% (2)	25% (14)	4% (2)
Anterior thigh	CD	75% (40)	7% (4)	2% (1)	0% (0)	6% (3)	2% (1)	4% (2)	4% (2)
	Non-CD	79% (44)	9% (5)	2% (1)	0% (0)	2% (1)	5% (3)	2% (1)	2% (1)
Anterior lower leg	CD	70% (37)	7% (4)	4% (2)	2% (1)	6% (3)	6% (3)	6% (3)	0% (0)
	Non-CD	71% (40)	12% (7)	2% (1)	0% (0)	0% (0)	5% (3)	4% (2)	5% (3)

^a Pain in the thigh and lower leg regions means that pain has been marked in one or both thighs/legs

^b >2 symbols denotes that pain has been marked using more than two symbols or that, if both legs have been marked, different symbols have been used for each leg

Table 2 Pain score (mean±SD, Mann-Whitney test, two-tailed) and percentage of non-organic drawings (χ^2 statistics, two-tailed) according to responses to the work- and social status-related questions in the questionnaire

	Pain score	<i>P</i> -value	Non-organic drawing	<i>P</i> -value
Currently working: Yes/No	3.14±3.01 / 4.03±2.98	<i>P</i> <0.071	24% / 46%	<i>P</i> <0.020
Without work: Yes/No	3.30±2.11 / 3.69±3.22	<i>P</i> <0.980	40% / 37%	<i>P</i> <0.826
Changed work due to back problems: Yes/No	4.61±3.77 / 3.20±2.45	<i>P</i> <0.110	39% / 36%	<i>P</i> <0.748
On sick-leave due to back problems: Yes/No	5.08±3.53 / 3.29±3.02	<i>P</i> <0.064	35% / 37%	<i>P</i> <0.823
Fired/quit due to back problems: Yes/No	4.51±3.23 / 3.13±2.93	<i>P</i> <0.018	44% / 31%	<i>P</i> <0.191
Applied for pension due to back problems: Yes/No	4.46±3.00 / 2.86±2.63	<i>P</i> <0.002	46% / 27%	<i>P</i> <0.053
Pensioned due to back problems: Yes/No	4.57±3.22 / 3.02±2.62	<i>P</i> <0.008	47% / 30%	<i>P</i> <0.081
Ongoing compensation case: Yes/No	4.59±3.92 / 3.55±2.86	<i>P</i> <0.364	47% / 35%	<i>P</i> <0.346

non-organic drawing. This was, however, not a significant finding.

Dallas Pain Questionnaire scores increased when going from the group with organic pain drawings through the two “possible” groups (possible organic/possible non-organic), to the group categorised as non-organic (Fig. 2). Using the pooled score, patients categorised as non-organic had significantly higher scores in all four categories of the Dallas Pain Questionnaire (*P*-values between 0.001 and 0.007), as well as in both the back- and leg-related questions in the Low Back Pain Rating Scale (*P*<0.0005). Smoking history (preoperative, postoperative, present smoking) was not associated with classification as non-organic.

Pain score

There was no difference in the pain score between the CD and the non-CD group (mean±SD: CD = 3.74±3.32, non-CD = 3.71±2.75, *P*=0.741). The overall mean score was 3.72±3.03. Women were found to have a significantly higher

Fig. 2 Boxplot of the score in the four Dallas Pain Questionnaire (DPQ) categories according to the classification obtained using the visual inspection method

score than men (mean $\pm$ SD: 4.38 $\pm$ 3.36 vs 3.11 $\pm$ 2.56, $P=0.048$). Smoking history did not influence the score. There was a close association between pain score and the result of the visual inspection method (mean $\pm$ SD: organic = 2.32 $\pm$ 1.98, non-organic = 6.05 $\pm$ 3.05, $P=0.001$).

Using Pearson correlation, the pain score correlated significantly with both the DPQ (r -values between 0.52 and 0.33, all P -values <0.001 ; best correlation with Daily Activity category) and the LBPRS score (r -values between 0.48 and 0.58, all P -values <0.001 ; best correlation with the questions regarding leg pain).

Many socio-demographic variables were found to influence the pain score (Table 2). The difference in the "currently working" question could, however, be explained by both a significantly higher number of women in the not working category and an almost significantly higher number of women in the "applied for pension due to back problems" group.

Those answering "yes" to the question: "Would you undergo the operation again now that you know the result?" had a significantly lower score than those answering "no" (mean $\pm$ SD: 3.34 $\pm$ 2.91 vs 4.90 $\pm$ 3.22, $P=0.011$).

Donor site pain

Eleven patients' pain drawings (10%) were interpreted as indicating donor site pain; in 24 patients (22%) the presence of donor site pain could not be excluded, 74 patients (68%) were judged to be without donor site pain. These findings did not differ between the two treatment groups. There was no effect of smoking history (preoperative, postoperative and present smoking status) on the presence of donor site pain. There was no difference in incidence of donor site pain and classification as non-organic/organic. There was no difference in pain score between the three donor site pain groups. However, those classified as having donor site pain had significantly poorer DPQ scores than the two other groups (possible and no donor site pain), though this relationship did not hold between the social concerns category of the DPQ and possible present donor site pain. Donor site pain was also associated with lower back-related LBPRS scores, although this reached near significance only for worst back pain within the last 14 days. There was no relation between willingness to go through the operation again or gender and the presence of donor site pain.

Discussion

This study revealed a high incidence of pain 5 years after posterolateral spinal fusion surgery, as reported by the pain drawings. This should not detract from the fact that the patients in general improved significantly over the 5 years [9]; it is, however, a reminder that lumbar spinal

fusion is not necessarily a pain removing, but rather a pain reducing, operation. Twenty-one percent were, however, without low back pain. That there was no difference between the instrumented and non-instrumented group further supports the result from the original study [9, 38], and several other studies [11, 13, 25], showing no benefit of additional pedicle-screw instrumentation.

The pain score method used in this study was a simplified version of those used by Margolis et al. [22] and Parker et al. [32], much like the simplified method suggested by Ohnmeiss et al. [30]. Such scoring methods have been shown to have a very high reliability/repeatability [22, 28, 32], and furthermore offer the advantage that non-experts can perform scoring, as it involves no clinical judgement. Using this simple method, we found no difference between the two treatment groups.

We found the pain score to be significantly lower among patients who were working at the time of making the drawing. The higher scores among patients not working were due to higher scores among those who were either on sick leave or had been fired or quit their job because of their back-related problems and among those who were on or applying for a pension. This could reflect the fact that patients not in work are those with most severe pain, or it could reflect an increased number of hysterical/hypochondriac patients in the group not working. Most likely it is a combination of both. Margolis et al. [22] found in their initial study describing the body surface system scoring method that 56% of the variance in Ransford's penalty point system, which reflects psychological disturbance [34], could be explained by the body surface ratings. They interpreted this as indicating that the body surface scoring system is highly predictive of psychological distress/dysfunction. Parker et al. [32] showed in their study that their pain sites scores correlated most strongly with measures of psychological distress, but not in their view to a satisfactory level. Using an area-based score, Öhlund et al. [27] showed that variance in this score reflected medical and psychological factors as well as subjective disability and psychosocial factors. That the pain score used in this study also reflects several of these variables is perhaps suggested by the fact that we found a high pain score to be correlated with low scores in all four categories of the DPQ – the daily and work-leisure activity categories, which give a measure of disability, and the anxiety-depression and social concern categories, which give a measure of psychological distress. High pain scores also correlated with low scores on the pain questions of the LBPRS, reflecting the pain component of the score. An ongoing compensation case was, however, not associated with significantly higher scores, despite the fact that ongoing compensation cases have been shown to be associated with poor outcome [6, 9, 12, 16, 17] and less improvement in pain drawing scores after fusion surgery [7].

The second method of scoring the pain drawings in this study was the classification established by Uden et al.

[40], based on Ransford's scoring method [34]. Although this classification involves clinical judgement, it has been shown to have good reliability and repeatability, which can be increased by pooling the groups together [8, 24, 28, 40]. The classification as "non-organic" is thought to reflect a substantial psychogenic component of the patients' back pain [10, 17, 34]. Using this method, no differences between the groups were seen.

The findings of the visual inspection method also correlated with the DPQ, the LBPRS and the pain score. However, the association with the various socio-demographic variables factors in the DPQ was not as strong as the association between these variables and the pain score. Using Ransford's method, McNeill et al. [23] found no correlation between a non-organic pain drawing and a decreased return to work rate in their study on low back pain patients seen in an outpatient orthopaedic clinic, although they did find that a non-organic pain drawing was associated with increased medication and a poorer outcome. In contrast to their findings, we found that status as currently working was associated with an increased percentage of organic pain drawings. This finding could, however, be explained by an increased number of men in the working category. We observed a significantly larger number of non-organic pain drawings among women than men. In a study of patients attending an outpatient chiropractic clinic, Bolton found that female patients scored higher in questionnaires measuring psychological distress [4]. The same strong gender influence was seen on the pain score.

According to the present investigation, at least 10% of patients have some degree of pain arising from the donor site 5 years after surgery. This number has, of course, to be interpreted carefully, as a subjective evaluation was used. It does, however, not differ considerably from numbers reported in the literature [2, 14, 36]. The incidence of

donor site pain has been reported to be higher among patients who consider their fusion unsuccessful [36]. We did not observe any relation between satisfaction with the operation, measured as willingness to go through the operation again when knowing the result, and the presence of donor site pain. Those classified as having donor site pain did, however, have poorer DPQ and LBPRS Back scores than the others. This could reflect the fact that those categorised as having donor site pain are found among the patients with more complex residual back pain, indicating that the subjective evaluation is of no use, or it could reflect the fact that those who indicate donor site pain are more focused on their pain perception, and therefore also score higher pain scores in general. There was, however, no difference between those with and those without donor site pain either on the pain score or on the number of non-organic pain drawings. It therefore seems a reasonable guess that 10–15% of posterolateral spinal fusion patients still suffer donor site pain to some extent 5 years after surgery.

Conclusion

About 20% of operated patients are without any low back pain 5 years after their surgical procedure. Assessed from pain drawings, around 10% still experience donor site pain at long-term follow-up. In general, instrumentation does not affect the amount and localisation of pain 5 years after lumbar spinal fusion surgery. Both a surface-based and an impression-based method of scoring pain drawings were found to correlate significantly with both the DPQ and the LBPRS. Based on this, the pain drawing seems to be a valuable tool when following spinal fusion patients, but its use as prognostic marker in connection with fusion surgery has to be investigated further.

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