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Failed back (surgery) syndrome: time for a paradigm shift

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Summary points

1. The group of patients with so-called 'failed back surgery syndrome' (FBSS) is very diverse. Published studies evaluating the outcome of surgical treatment vary widely in terms of surgical interventions that were performed. Results from these papers cannot be generally applied to all people who have persisting complaints after low back surgery.
2. The literature search that was performed demonstrated that the articles that scored as acceptable on assessment bias demonstrated a low to moderate patient-perceived recovery percentage. The only randomized controlled trial on this topic did not demonstrate a difference between instrumented fusion and cognitive intervention and exercise.
3. Current research does not show repeat surgery to be successful in 'FBSS patients', but clinical practice indicates that, in a small, carefully selected group, repeat surgery can yield rewarding results. However, parameters that make a patient prone to recover from a subsequent surgical intervention cannot be found in the literature.
4. The term 'failed back surgery syndrome' implies a causative role of surgery in a problem situation; failed back surgery syndrome is frequently regarded as failed back surgery. The literature does not, however, provide evidence for this.
5. It is important to inform the patient adequately to shape realistic expectations. Preoperative evaluation of parameters evaluating the psychological condition could help to better predict the outcome of surgery.
6. The term 'failed back surgery syndrome' has been demonstrated to be an ill-defined term, serving as a container for all kinds of back and leg problems, and wrongly implying a definite role for the surgical intervention in the aetiology. We suggest shifting the paradigm to 'failed back syndrome'. With this term we suggest defining those patients with back and radicular leg pain without a structural deficit, or with a structural deficit that has a low a priori chance of benefiting from a surgical intervention.

Keywords

Failed back, spine surgery, lumbar spondylodesis, low back surgery, revision low back surgery

Introduction

The term 'failed back surgery syndrome' (FBSS) is used to describe a clinical condition defined by persistent or recurrent complaints of leg pain and/or back pain regardless of one or more surgical procedures of the lumbar spine. The definition of FBSS is modified by some authors by adding that at least one surgical intervention was to be performed and that pain should persist after the last surgical intervention, for at least one year.¹ The term implies that the surgery plays a

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role in the cause of the pain, although in most cases the surgical intervention was technically successful. It is known that nearly 20% of patients undergoing spine surgery will require secondary surgery for persistent pain or surgery-related complications during the subsequent years.² Success rates have been reported to drop to 30% after a second spine surgery, 15% after a third and approximately 5% after a fourth.³

If back and/or leg pain persists for too long or if the patient is psychologically unable to deal with the pain, the medical care-giver is confronted with a desperate patient with persistent disabling chronic pain. This patient category is typically referred to as FBSS in most studies. Nevertheless, the term is often incorrectly used for low back pain that is difficult to treat.

Factors contributing to FBSS include misdiagnosis of the original condition, divergent outcome expectations between surgeon and patient, wrong surgical technique, surgical complications, recurrent disc herniation and psychosocial problems.^{1,4-7} A specific cause of pain cannot be identified in many patients with FBSS. Pain may arise from viscera, blood vessels, nerves, bones of the spine and pelvis, muscles, or joints.

In order to place the entity of FBSS into perspective, one should realize that there are many patients with chronic low back pain. A simple classification of low back pain and leg pain is proposed by Waddell et al.:⁴ (1) pain caused by specific spinal pathology, e.g. tumour, infection or trauma, (2) nerve root or radicular pain and (3) nonspecific low back pain. The last group constitutes a large heterogeneous group of patients and concerns about 85% of the total number of cases.

Every human being will demonstrate degeneration of the lower back upon aging. In most people progression of degeneration will lead to some extent of low back pain. Whenever the degeneration cascade also affects neural structures that are subsequently decompressed, the back pain may remain present. Surgical interventions aiming at relief of nonspecific low back pain have a low a priori chance of being successful. There is a huge variation in aging patients, implying that several factors may play a role. Some of these factors are strictly medical, whereas others are socio-economic. 'Workers' compensation' for instance, is an economic incentive for spinal stenosis surgery. Patients will not benefit medically from such economically driven incentives, and surgery for these motives is likely to result in poor outcomes. This may be a reason for figures in the literature stating that 13–20% of patients undergoing spine surgery require secondary surgery during subsequent years.^{3,8}

The common factor in patients with FBSS is that they continue to seek treatment to relieve their pain. However, patients and treatments vary and so do the

results. An overview will be presented of the literature describing the surgical treatment of patients suffering from FBSS; thereafter we will discuss our view of the term FBSS.

Methods

Search methods for identification of studies

A search was conducted by an epidemiologist (WJ) in PubMed, Cochrane Central Register of Controlled Trials, and Web of Science up to May 2012 for English-language papers by entering 'fbss' OR ('failed back' AND 'surgery') OR 'post laminectomy syndrome' OR 'failed back surgery syndrome'. This resulted in 629 hits. Four hundred and eighty-seven non-clinical studies were excluded and 135 articles were full text screened. Communication with experts (MA, WP) yielded one more article.

Criteria for considering studies for this review. We included studies reporting on surgical interventions for FBSS with a follow-up period of at least 6 months (at least one surgical low back intervention in the past and persistent pain complaints). Exclusion criteria were absence of outcome measures of the specific treatment, cost-effectiveness study, review, conference proceeding, preliminary results, no indication mentioned, fewer than 10 patients included, and follow-up of less than 6 months.

Assessment of risk of bias for the included studies. One author (CV-L) conducted the risk-of-bias assessment. Selection bias, patient selection and outcome scoring were evaluated. If selection bias was absent, three points were assigned: one point was subtracted for retrospective data analysis, one point was subtracted for intentionally omitting patients and one point was subtracted for more than 20% lost to follow-up (LTFU). Patient selection is crucial in judging the outcome of surgery on FBSS patients, and if the selection was correct two points were assigned. If redisectionomy or restenosis surgery was included one point was subtracted and if spondylodesis was performed for recurrent complaints with a self-limiting character or for complaints that could have been solved with a simple surgical decompression one point was subtracted. Outcome scoring with validated parameters was scored as two points: one point was subtracted for evaluating outcome with a non-validated parameter, and one point was subtracted if no patient-reported outcome measure was applied. One point was awarded for including a control group. The number of positively scored items was added up for each study.

Table 1. Demographic data.

	M:F (%)	Mean age (years)	Mean duration of complaints (months)	Mean follow-up (months)
Kaner, 2010 ¹³	57:43	49	–	24
Kim, 1991 ¹⁴	34:66	51	67	59
Arts et al., 2012 ¹	49:51	54	–	15
Duggal et al., 2004 ⁸	27:73	52	12	22
Skaf, 2005 ¹⁵	40:60	54	–	12
Wong, 2001 ¹⁶	36:64	55	–	38
North et al., 1991 ¹⁷	54:46	49	92	24
Badawy, 2006 ¹⁸	60:40	47	28	36
Fritsch et al., 1996 ¹⁹	72:28	–	–	132
Lakkol et al., 2011 ²⁰	50:50	47	–	36
Jang et al., 2007 ²¹	10:90	62	–	31
Brox et al., 2006 ¹²	52:48	43	97	12

Data collection and analysis. From each study, both descriptive data (e.g. study population, types of treatment, types of outcome assessment, sample size, age, gender, follow-up duration) and quantitative data regarding outcome were extracted by one reviewer (CV-L). With sufficient clinically and statistically homogeneous and comparable reported outcomes, data were pooled with the aid of RevMan 5 for studies with control group and Excel for case series. To identify publication bias, funnel plots were examined.

Results

A total of 43 studies met the inclusion criteria. Fifteen of these studies reported on surgical interventions for FBSS. From three studies, only the abstract was available, and they were excluded from this review.^{9–11} A total of 12 studies were eventually identified for use in this review; one was a randomized controlled trial and the others were all case series (none with control groups).¹²

Demographic data

The number of men and women in most studies was more or less comparable, and the mean age of the described patients was about 50 years (Table 1). The mean preoperative duration of complaints was documented in only a few articles; in all articles it was more than 6 months, according to our inclusion criteria. The mean follow-up varied from 12 months to 11 years.

Assessment of risk of bias

All articles, except those by Lakkol et al.²⁰ and Brox et al.,¹² retrospectively evaluated their data and are thus, by definition, subject to selection bias. The surgeon makes the decision regarding who receives a surgical intervention, and the surgeon also decides on the type

of surgical intervention (Table 2). Although Lakkol evaluated patients prospectively, no comment was given on selection of patients, and thus the risk of selection bias also applied to these data. The only randomized controlled trial was by Brox; patients were randomized between instrumented fusion and cognitive intervention with exercises, so it had no selection bias.

Many of these articles described a group of patients who can be judged as FBSS patients, since they had undergone a lumbar spine surgical intervention and they still had complaints. However, a distinction should be made between patients with structural deficits and those without. The a priori chance of improvement after surgery increases with the presence of a straightforward indication, such as a first recurrence of a disc hernia or a second level of spinal stenosis. In this overview, this lack of distinction introduces bias. If patients with a first-time recurrent disc herniation were treated with a discectomy with fusion,^{13,20} the results are expected to be good, though the intervention is too comprehensive. If, on the other hand, only a redisecectomy is performed with a good result,^{19,22,23} then the population described does not, in our opinion, belong to the patients who should be defined as having failed back (surgery) syndrome.

Outcome evaluation by scoring the patient's opinion on whether the intervention was successful was performed in only a minority of papers.^{1,12,17,20,21} Only Brox et al. compared results with a control group.¹² Three articles reported no conflict of interest,^{1,17,20,21} Brox et al. reported support by national health organizations¹² and the other papers did not mention this.

Clinical outcome

In general, the authors concluded that the outcome of the surgical intervention being performed was (very) successful (Table 3). VAS leg and/or back pain

Table 2. Assessment of risk of bias.

	Selection bias	Patient selection	Outcome scoring
Kaner et al., 2010 ¹³	**	—	*
Kim, 1991 ¹⁴	*	—	—
Arts et al., 2012 ¹	**	**	**
Duggal et al., 2004 ⁸	**	*	—
Skaf, 2005 ¹⁵	*	—	**
Wong, 2001 ¹⁶	**	—	—
North et al., 1991 ¹⁷	*	**	**
Badawy, 2006 ¹⁸	**	*	—
Fritsch et al., 1996 ¹⁹	*	—	*
Lakkol et al., 2011 ²⁰	**	—	**
Jang et al., 2007 ²¹	**	**	**
Brox et al., 2006 ¹²	***	**	**

One * accounts for one point. Brox et al. (2006)¹² also get a point for comparing with a control group (randomized controlled trial).

Table 3. Clinical outcome.

	Pain score	Outcome pain score	Functionality score	Outcome	Patient-validated outcome/working status
Kaner, 2010 ¹³	VAS	Significant decrease from 7 to 1	ODI	Significant decrease from 67 to 7	
Kim, 1991 ¹⁴	Grade I–III, non-validated scale	Decrease by one grade in 66%			
Arts et al., 2012 ¹	VAS back and leg	At follow-up VAS back 45 mm and VAS leg 38 mm, no comparison with preoperative situation	ODI	At FU 30, no comparison with preoperative situation	Likert perceived recovery: 35% satisfactory result
Duggal et al., 2004 ⁸	Grade 1–5, non-validated scale	Preoperative 100% grade 5, postoperative 100% grade 1–4: 76% (back) and 80% (leg) improvement	Grade 1–5, non-validated scale	Improvement 67%	8 of 33 patients returned to work, preoperatively 8 of 33 patients worked
Skaf, 2005 ¹⁵	% more than 50% pain reduction	92%	ODI	Significant decrease from 81 to 24	
Wong, 2001 ¹⁶	VAS leg pain	Not reported	Grade 1–5, non-validated scale		84% returned to work, preoperatively 84% worked
North et al., 1991 ¹⁷	VAS leg pain, % more than 50% pain reduction	36%			% more than 50% pain reduction and satisfactory result: 32%
Badawy, 2006 ¹⁸	Grade 1–4, non-validated scale	80% grades 1 and 2			
Fritsch et al., 1996 ¹⁹					Grade 1–3, non-validated scale: 22% satisfactory result
Lakkol et al., 2011 ²⁰	VAS leg pain	Significant decrease from 6.5 to 3.7	ODI and SF36	ODI: significant decrease from 54 to 29 SF36: significant increase from 27 to 42	

Table 3. (Continued)

	Pain score	Outcome pain score	Functionality score	Outcome	Patient-validated outcome/working status
Jang et al., 2007 ²¹	VAS leg pain	Significant decrease from 7 to 3	ODI	Significant decrease from 62 to 36	Macnab: 84% satisfactory outcome
Brox et al., 2006 ¹²	VAS back and leg pain	Surgery: VAS back significant decrease from 65 to 51, VAS leg decrease from 53 to 45. Cognitive therapy: VAS back significant decrease from 65 to 50, VAS leg significant decrease from 55 to 48, no difference between surgery and cognitive therapy	ODI	Surgery: significant decrease from 47 to 38. Cognitive therapy: significant decrease from 45 to 32. No difference between surgery and cognitive therapy	GBDQ success rate: surgery 50%, cognitive therapy 48%, no difference between surgery and cognitive therapy

decreased, functionality improved and the patients were satisfied. Many authors used non-validated scores to measure outcome. Patient self-reported outcomes were scored by Arts et al.,¹ North et al.,¹⁷ Fritsch et al.,¹⁹ Jang et al.,²¹ and Brox et al.¹² Of these Arts, North and Fritsch reported a satisfactory result in only one-third or less of the patients. Jang, however, reported a satisfactory outcome in 84% of patients. Notably, the patients operated by Jang were a different population; all patients had undergone instrumented surgery and were re-operated because of sagittal imbalance. Sagittal balance was redressed by means of radical surgical interventions.

In the only randomized controlled trial on this topic, Brox reported a significantly improved Oswestry Disability Index (ODI) 1 year after fusion, a significant decrease in back pain and a success rate of 50% after 1 year.¹² However, comparable results were reported in the group of patients that randomly received conservative treatment by cognitive intervention and exercises, and there were only minor statistically significant differences between the surgical and conservative groups.

Complications and revision surgeries

Complications, if described, varied between 10% and 20% (Table 4). The complications mentioned were mostly disabling and included, among others, cauda syndrome and paraparesis. Revision surgery was described in only five articles. In three of these, revision surgery was performed in about one-third of patients. In the other two articles it was reported that revision surgery was not needed.^{12,20}

Combining data on bias and outcome

The papers that have the highest scores on the combination of absence of selection bias, patient selection and outcome scoring are by Brox et al. (eight points),¹² Arts et al. (six points),¹ North et al. (five points)¹⁷ and Jang et al. (six points).²¹ The articles by Brox et al., Arts et al. and North et al. are three of the four that evaluated patient satisfaction and reported that only one-third to one-half of patients judged their result as satisfactory. Jang et al.'s article also evaluated patient satisfaction, and documented 84% of the patients as satisfied. Notably, as remarked earlier, the patients operated on by Jang are a different population. The described patients had previous back surgery with instrumented spondylodesis before, influencing sagittal balance. Sagittal balance was redressed by means of a comprehensive surgical intervention.

It was concluded that data were clinically and statistically too heterogeneous to pool. Not enough information was provided to identify publication bias by funnel plot examination.

Discussion

In this paper the term 'failed back surgery syndrome' is reserved for patients with persistent leg and/or low back pain regardless of one or more surgical interventions in the past. There was a wide variation in the type of surgical interventions that were performed in the included studies. The term FBSS is used for patients who had a recurrent herniated disc but also for patient who endured several instrumented low back surgeries. It is

Table 4. Complications and revision surgeries.

	Major complications	Revision surgery
Kaner, 2010 ¹³	5%	
Kim, 1991 ¹⁴	12%	28%
Arts et al., 2012 ¹		
Duggal et al., 2004 ⁸		
Skaf, 2005 ¹⁵		
Wong, 2001 ¹⁶	10%	
North et al., 1991 ¹⁷		23% (33% of these patients were successful after 2 years)
Badawy, 2006 ¹⁸		
Fritsch et al., 1996 ¹⁹	21%	34% (one or more revisions)
Lakkol et al., 2011 ²⁰	14%	No revisions
Jang et al., 2007 ²¹		
Brox et al., 2006 ¹²	9% wound infections	No revisions

obvious that the group of patients is thus very diverse, and that results from these papers cannot be generally applied to all subjects with persistent complaints after low back surgery.

The term ‘failed back surgery syndrome’ has been demonstrated to be an ill-defined term, serving as a container for all kinds of back and leg problems, and wrongly implying a definite role for the surgical intervention in the aetiology. We suggest shifting the paradigm to ‘failed back syndrome’. We suggest using this term to refer to those patients with back and radicular leg pain without a structural deficit, or with a structural deficit that has a low a priori chance of benefiting from a surgical intervention.

Currently, the gold standard in the treatment of FBSS involves conservative management. Pain medication and pain intervention such as medial branch block, epidural steroids, intrathecal drug administration and spinal cord stimulation (SCS) need to be evaluated. Preferably, these approaches should be carried out by an interdisciplinary team.²⁴

Evidence-based guidelines on various treatment regimes of patients with FBSS are lacking since high-quality randomized controlled trials on this topic are scarce. The results of Brox et al.¹² were discussed in this paper, concluding that lumbar fusion did not show any superiority over cognitive intervention and exercise. Kumar et al.²⁵ randomized 100 patients with FBSS in conventional pain medication management with or without spinal cord stimulation. Patients treated with additional SCS reported better pain relief, functional ability and patient satisfaction. However, given the large number of crossovers, the results should be interpreted carefully. North et al.²⁶ randomized 50 patients with FBSS in reoperation and SCS. Similarly, it was found that significantly more patients from the reoperation group crossed over to the SCS group. Patient satisfaction and pain control were significantly

higher in the SCS group, both randomized and crossover, making SCS more successful than reoperation.

The literature search that was presented in this paper demonstrated that there are not many articles that evaluate surgical intervention in patients with FBSS, that most of these articles are subjected to selection bias, that the variation in the applied surgical interventions and the indications is wide, and that the evaluation of outcome is often of poor quality. Only three articles score acceptable on assessment bias, and those articles demonstrate a low to moderate patient-perceived recovery percentage. It should be noted that Arts demonstrated that the perceived recovery is scored low, while the VAS leg and back pain and the ODI scores were acceptable. This tones down the outcome scores of most articles that did not include patient-reported outcomes. Current research does not show repeat surgery to be successful in this group of patients but clinical practice points out that in a small, carefully selected group repeat surgery can yield rewarding results. It would be interesting to know what parameters make a patient prone to recover from a subsequent surgical intervention. The literature, however, does not provide an answer. However, it seems reasonable to expect that those patients with a clinically correlating structural abnormality are most likely to benefit from a surgical intervention.

The term ‘failed back surgery syndrome’ implies a causative role of surgery in a problem situation. Generally, however, the term is reserved for patients who are operated on for low back problems, with or without neurological symptoms, in which the outcome of surgery was not satisfactory for the patient. It is possible that the complaints got worse after surgery, but a causative role for the surgical intervention is not obligatory for FBSS, or FBS as we suggest calling it. It has to be added, though, that the trend to treat spinal stenosis with complex fusion procedures is associated

with increased risk of major complications, as described by Deyo.²⁷ A bad outcome of that type of surgical intervention does contribute to the negative view on the role of surgery in FBS patients.

If a patient continues to have persistent leg and/or back pain after a surgical intervention, it is caused either by inadequate performance of the applied surgical intervention or by additional factors that could not be solved with the performed intervention. It was documented before that long-term patient satisfaction after low back surgery for a herniated disc is absent in around 20–30% of subjects.^{28,29} If the initial surgical intervention was inadequate, a further surgical procedure can be performed to achieve the original aim. If additional factors play a role, it is often difficult to pinpoint the causative factor. If a mechanical (sagittal balance) or dynamic (stability) component plays a role, spondylodesis can be a solution. It is, however, important to inform the patient adequately to shape realistic expectations. The psychological status of the patient plays an important role in this. It is very important to evaluate this condition before surgery is performed. Appropriate patient selection is mandatory to prevent unnecessary surgery and unsatisfactory outcome. If recurrent back surgery is evaluated, outcome parameters evaluating this psychological condition, such as the HADS (Hospital Anxiety Depression Scales), IPQ-K (measuring illness perception), and/or DS-14 (type D personality questionnaire) should be scored. (A type D personality has a tendency towards both negative affectivity and social inhibition.)

Conclusion

The term 'failed back surgery syndrome' as it is used nowadays applies to a group of patients with a broad variation in surgical history and indication, wrongly implies a causative role for the surgical intervention, and is not subject to a clearly defined solution for the problems. The term should therefore be avoided, and replaced by 'failed back syndrome'. This term should be reserved for patients with back and radicular leg pain without a structural deficit, or with a structural deficit that has a low a priori chance of benefiting from a surgical intervention.

If a patient was subjected to a low back surgical intervention and still has significant complaints, pain management should be dealt with in a multidisciplinary team, considering pain medication or pain intervention, for instance SCS. Psychological evaluation in the work-up is mandatory. Only in a small minority of patients, a surgical intervention should be considered if clinically correlating structural abnormalities are present.

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References

1. Arts MP, Kols NI, Onderwater SM, et al. Clinical outcome of instrumented fusion for the treatment of failed back surgery syndrome: a case series of 100 patients. *Acta neurochir* 2012; 154: 1213–1217.
2. Hazard RG. Failed back surgery syndrome: surgical and nonsurgical approaches. *Clin Orthop Relat Res* 2006; 443: 228–232.
3. Martin BI, Mirza SK, Comstock BA, et al. Reoperation rates following lumbar spine surgery and the influence of spinal fusion procedures. *Spine* 2007; 32: 382–387.
4. Waddell G, Kummel EG, Lotto WN, et al. Failed lumbar disc surgery and repeat surgery following industrial injuries. *J Bone Joint Surg Am* 1979; 61: 201–207.
5. Spengler DM, Freeman C, Westbrook R, et al. Low back pain following multiple lumbar spine procedures. Failure of initial selection? *Spine* 1980; 5: 356–60.
6. Wiltse LL. Proceedings: Predicting the success of low back surgery by the use of preoperative psychological tests. *J Bone Joint Surg Br* 1975; 57: 259.
7. Waddell G, Kummel EG, Lotto WN, et al. Failed lumbar disc surgery and repeat surgery following industrial injuries. *J Bone Joint Surg* 1979; 61-A: 201–7.
8. Duggal N, Mendiondo I, Pares HR, et al. Anterior lumbar interbody fusion for treatment of failed back surgery syndrome: an outcome analysis. *Neurosurgery* 2004; 54: 636–643.
9. Biondi J and Greenberg BJ. Redecompression and fusion in failed back syndrome patients. *J Spinal Disord* 1990; 3: 362–369.
10. Colemont J, Heinrich E, Giehl JP, et al. Stabilization of the lumbosacral spine in postlaminectomy syndromes. Technique and 2-year results. *Acta Orthop Belg* 1991; 57 Suppl 1: 247–254.
11. Kaneda K, Higuchi M, Nohara Y, et al. Posterolateral fusion with instrumentation in the symptomatic failed back patients. *Nihon Seikeigeka Gakkai zasshi* 1984; 58: 323–330.
12. Brox JJ, Reikeras O, Nygaard O, et al. 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: 145–155.
13. Kaner T, Sasani M, Oktenoglu T, et al. Minimum two-year follow-up of cases with recurrent disc herniation treated with microdiscectomy and posterior dynamic transpedicular stabilisation. *Open Orthop J* 2010; 4: 120–125.
14. Kim SS and Michelsen CB. Revision surgery for failed back surgery syndrome. *Spine* 1991; 17: 957–960.
15. Skaf G, Bouclaus C, Alaraj A, et al. Clinical outcome of surgical treatment of failed back surgery syndrome. *Surg Neurol* 2005; 64: 483–489.
16. Wong C, Chen, W, Chen L, et al. Clinical outcomes of revision lumbar spinal surgery: 124 patients with a

- minimum of two years of follow-up. *Chang Gung Med J* 2001; 25: 165–182.
17. North RB, Campbell JN, James CS, et al. Failed back surgery syndrome: 5-year follow-up in 102 patients undergoing repeated operation. *Neurosurgery* 1991; 28: 685–690.
 18. Badawy WS, El Masry MA, Radwan YA, et al. Results of instrumented posterolateral fusion in failed back surgery. *Int Orthopaed* 2006; 30: 305–308.
 19. Fritsch EW, Heisel J and Rupp S. The failed back surgery syndrome: reasons, intraoperative findings, and long-term results: a report of 182 operative treatments. *Spine* 1996; 21: 626–633.
 20. Lakkol S, Bhatia C, Taranu R, et al. Efficacy of less invasive posterior lumbar interbody fusion as revision surgery for patients with recurrent symptoms after discectomy. *J Bone Joint Surg Br* 2011; 93: 1518–1523.
 21. Jang JS, Lee SH, Min JH, et al. Surgical treatment of failed back surgery syndrome due to sagittal imbalance. *Spine* 2007; 32: 3081–3087.
 22. Kim SS and Michelsen CB. Revision surgery for failed back surgery syndrome. *Spine* 1992; 17: 957–960.
 23. Wong CB, Chen WJ, Chen LH, et al. Clinical outcomes of revision lumbar spinal surgery: 124 patients with a minimum of two years of follow-up. *Chang Gung Med J* 2002; 25: 175–182.
 24. Chan CW and Peng P. Failed back surgery syndrome. *Pain Med* 2011; 12: 577–606.
 25. Kumar K, Taylor RS, Jacques L, et al. Spinal cord stimulation versus conventional medical management for neuropathic pain: a multicentre randomised controlled trial in patients with failed back surgery syndrome. *Pain* 2007; 132: 179–188.
 26. North RB, Kidd DH, Farrokhi F, et al. Spinal cord stimulation versus repeated lumbosacral spine surgery for chronic pain: a randomized, controlled trial. *Neurosurgery* 2005; 56: 98–106.
 27. Deyo RA, Mirza SK, Martin BI, et al. Trends, major medical complications, and charges associated with surgery for lumbar spinal stenosis in older adults. *JAMA* 2010; 303: 1259–1265.
 28. Arts MP, Brand R, van den Akker ME, et al. Tubular discectomy vs conventional microdiscectomy for the treatment of lumbar disk herniation: 2-year results of a double-blind randomized controlled trial. *Neurosurgery* 2011; 69: 135–144.
 29. Peul WC, van den Hout WB, Brand R, et al. Prolonged conservative care versus early surgery in patients with sciatica caused by lumbar disc herniation: two year results of a randomised controlled trial. *BMJ* 2008; 336(7657): 1355–1358.