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ORIGINAL ARTICLE

Predictors of surgical, general and follow-up complications in lumbar spinal stenosis relative to patient age as emerged from the Spine Tango Registry

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Abstract
Introduction Published opinions regarding the outcomes and complications in older patients have a broad spectrum and there is a disagreement whether surgery in older patients entails a higher risk. Therefore this study examines the risk of surgery for lumbar spinal stenosis relative to age in the pooled data set of the Spine Tango registry.
Materials and methods Between May 2005 and February 2010 the database query resulted in 1,764 patients. The patients were subdivided into three socio-economically relevant age groups: <65 years, 65–74 years, ≥75 years. Frequencies for occurred surgical, general and follow-up complications were assessed. Multivariate and univariate logistic regressions were performed to reveal predictors for respective complication types.
Results and discussion Our study found that age, ASA status and blood loss were significant co-varieties for the occurrence of general complications. The risk of general complications is increased in older versus younger patients. Fusion or rigid stabilization does not lead to more complications. Surgical complications as well as complication rates at follow-up showed no significant age-related variation. Physician-based outcome was good or excellent in over 80% of patients in all age groups.

Keywords Spine Tango · Surgical, follow-up and general complications · Spinal stenosis · Elder patients · Registry

Introduction

With the absolute and relative growth of the aged part of the population in the industrialized countries the prevalence of chronic back pain is also growing and the number of elderly patients requiring spine surgery continues to increase [4, 8, 11]. One of the most frequent degenerative conditions in the aged spine is lumbar spinal stenosis (LSS), which generally becomes symptomatic after the age of 50 [17]. Clinical manifestations of LSS can severely limit patients' mobility, leading to serious health-related and psychosocial consequences including depression and isolation [9]. Because conservative therapy is usually only effective in a short-term [1], surgical decompression is considered the only remaining treatment option for preserving or improving the quality of life and health status in many cases.

Surgical treatment of LSS for patients over 65 years is the most commonly performed surgical procedure in the spine [4]. Such surgeries can be more or less invasive. As always, operative risks must be weighed against expected benefits. Patient age is often a decision-influencing factor. In the past and even today, age is regarded as a relative contraindication for elective spine surgery. Published opinions regarding the outcomes and complications in older patients have a broad spectrum and there is a disagreement whether surgery in older patients entails a higher risk [6–8, 13, 18, 19, 21, 22].

Rolf Sobottke and Emin Aghayev have equally contributed to the study.

On behalf of the Spine Tango Registry Group.

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The current study was carried out on the basis of Spine Tango, the international spine registry of EuroSpine, the Spine Society of Europe. Spine Tango was developed at the University of Bern's Institute for Evaluative Research in Medicine (IEFM) in cooperation with EuroSpine and is also hosted there [15, 20, 25]. Since its initiation, patient and physician-based data have been gathered in a prospective observational multi-center mode. This study examines the risk of open decompression for LSS relative to age in the pooled data set of Spine Tango.

Methods

Between May 2005 and February 2010 26,934 surgical procedures dealing with various spinal pathologies have been documented. The current study applied the following inclusion criteria:

- lumbar degenerative spinal stenosis
- open decompression only or decompression with stabilization and/or fusion
- posterior approach
- at least one documented follow-up (FU)
- no additional spinal pathology such as deformity, fracture, trauma, spondylolisthesis, inflammation, infection, tumor or failed surgery

The database query resulted in 1,764 patients from 29 Spine Tango clinics. The patients were subdivided into three socio-economically relevant age groups: (1) <65 years, (2) 65–74 years, and (3) ≥75 years. Characteristics of these groups are summarized in Table 1.

Comparisons of preoperative patient characteristics were performed using chi-square test, Wilcoxon signed-rank test, Wilcoxon-Mann–Whitney test or logistic regression depending on the type of variable. Bonferroni corrections were applied for p-values to account for multiple testing.

Frequencies for occurred surgical, general and follow-up complications revealed at any point of follow-up were assessed. Patient-based rates were calculated. In the analysis of FU complications, all documented follow-ups were considered. A follow-up complication was defined as a complication, which was newly detected after patient discharge.

Multivariate and univariate logistic regressions were performed to reveal predictors for respective complication types. As co-variates, age group (<65 years, 65–74 years, ≥75 years), gender (male, female), ASA risk status (American Society of Anesthesiologists) (1–5), rigid stabilization or fusion (yes/no), dynamic stabilization (yes/no), extent of lesion (1, 2–3, >3 segments), number of previous surgeries (0, 1, >1), operation time (<2, ≥2–4 h), and most severely affected segment (L1/2, L2/3, L3/4, L4/5, L5/S1) were evaluated. The co-variates were also assessed separately within each age group. Correlation according to Spearman was used for the analysis of relation between operation time and surgical complications.

The Hosmer and Lemeshow Goodness-of-Fit test was used to assess model stability. The level of significance was set to 0.05 throughout the study. All statistical analyses were conducted using SAS 9.2 (SAS Institute Inc, Cary, NC,USA).

Results

Physician-based outcome

Analysis of physician-based outcomes (excellent, good, fair and poor) at follow-up showed no significant differences between the age groups (Table 2).

Surgical complications

Complications have a multiple choice answer format on the Spine Tango questionnaires. We did count each single event and not the occurrence of complications per se. Hence, the number of reported complications per group can be higher than the number of cases in that group. For group 1, 30 complications were documented in 30 patients (patient-based rate 4.3%); for group 2, there were 38 complications in 37 patients (6.3%); and in group 3 there were 28 complications in 26 patients (5.4%). The patient-based complication rate for the complete sample was 5.3%. The most frequent surgical complications were dura lesions. Documented surgical complications are summarized in Table 3.

Multivariate logistic regression revealed only surgery time ($p < 0.001$) as a significant co-variate for surgical complications.

According to the regression, the likelihood to observe complications was 2.6-times higher (95% confidence interval (95%CI) 1.7–4.2) if the surgery lasted 2 h or longer compared with surgeries lasting less than 2 h. However, there was a low correlation between the surgical complications and surgery time ($r = 0.13$; $p < 0.001$). No other co-variate like group affiliation had a significant influence on the occurrence of surgical complications.

General complications

Group 1 showed 15 general complications in 12 patients (patient-based rate 1.7%), group 2 showed 12 complications in 11 patients (1.9%) and group 3 showed 24 complications in 21 patients (4.3%). The patient-based complication rate for the complete sample was 2.5%. The most frequent general complications were urinary tract infections (UTI) followed by cardiovascular complications.

Table 1 Age groups characteristics and comparisons among groups

	1G: <65years $n = 697$ (40%)	2G: 65–74years $n = 583$ (33%)	3G: ≥75years $n = 484$ (27%)	Total $n = 1{,}764$	1G versus 2G (p-value)	1G versus 3G (p-value)	2G versuss 3G (p-value)
Mean age (years)	55.5	70.2	80	67.2	n.a.	n.a.	n.a.
Age range (years)	25–64	65–74	75–92	25–92	n.a.	n.a.	n.a.
Females (%)	47	46	49	48	n.s.	n.s.	n.s.
Mean length of stay (weeks)	8	9	10	9	*<0.001*	*<0.001*	*<0.001*
Mean follow-up time (days)	139	119	111	125	*<0.001*	*<0.001*	*n.s*
Range follow-up time (days)	21–380	11–379	20–379	11–380	n.a.	n.a.	n.a.
Mean length of stay before OP (days)	1.2	1.3	1.2	1.2	*n.s.*	*n.s.*	*n.s.*
ASA 1 (%)	30	12	4	17	<0.001	<0.001	<0.001
ASA 2 (%)	55	56	49	54			
ASA 3 (%)	15	31	44	28			
ASA 4 (%)	1	1	3	1			
Decompression (%)	100	100	100	100	n.a.	n.a.	n.a.
Rigid stabilization or/and fusion (%)	32	31	24	30	n.s.	0.003	0.013
Dynamic stabilization (%)	7	4	4	5	0.020	0.008	n.s.
Monosegmental (%)	48	35	32	39	<0.001	<0.001	n.s.
Bi- and tri-segmental (%)	42	55	55	50			
More than three segments (%s)	10	10	13	11			
No previous surgery (%)	68	69	71	69	n.s.	n.s.	n.s
One previous surgery (%)	22	24	20	22			
Two or more previous surgeries (%)	10	7	9	9			
Operative time <2 h (%)	68	67	72	69	n.s.	n.s.	n.s.
Operative time ≥2 h (%)	32	33	28	31			
Blood loss "none"	18	12	11	14	0.005	<0.001	n.s.
Blood loss "<500 ml"	58	67	70	64			
Blood loss "500–1,000 ml"	20	17	17	18			
Blood loss "≥1,000 ml"	4	4	2	4			
Segment L1/L2 (%)	1	1	1	1	<0.001	<0.001	0.043
Segment L2/L3 (%)	5	7	10	7			
Segment L3/L4 (%)	20	26	31	25			
Segment L4/L5 (%)	58	59	50	56			
Segment L5/S1 (%)	16	7	8	11			

Italized values are calculation using two-sided Wilcoxon-Mann–Whitney test, for the remaining comparisons chi-square test was used

n.a. Not analyzed, e.g. regarding mean ages in the age groups

n.s. Not significant

Table 2 Physician-based outcomes

Outcome scaled by physician (%)	1G: <65years $n = 697$ (41%)	2G: 65–74years $n = 583$ (33%)	3G: ≥75years $n = 484$ (26%)	Total $n = 1764$
Excellent outcome	32	33	30	32
Good outcome	46	48	48	48
Fair outcome	17	16	17	17
Poor outcome	5	3	5	4

Group differences were not significant

These particular complications were also more prevalent in group 3 than in the other groups (Table 3).

Multivariate logistic regression revealed ASA status ($p < 0.001$) and blood loss ($p = 0.001$) as significant co-variates for general complications. A patient with ASA 3 had a 3.7-times (95%CI 1.8–7.8) higher likelihood for a general complication than a patient with ASA 2 as the largest and therefore the reference ASA group in the study. Patients with blood loss of at least 1,000 ml had a 10.2-times (95%CI 2–5.3) higher likelihood for a general complication than those without blood loss. There was no influence of the duration of operation on the general complication rate. Separate univariate regression analysis of general complications additionally showed an age effect ($p = 0.009$). A patient from group 3 had a 2.6-times (95%CI 1.3–5.3) higher likelihood for a general complication than one from group 1.

Complications at follow-up

In 1,333 documented FUs in group 1 (1.9 FUs/patient) 112 different complications in 79 patients had occurred (patient-based rate 11.3%). Group 2 had 1,014 FUs (1.7 FUs/patient) with 89 different complications in 60 patients (10.3%). Finally group 3 had 775 FUs (1.6 FUs/patient) with 66 different complications in 49 patients (10.1%). Thus, FU complications were more frequent than surgical or general complications, whereas there were comparable rates in the age groups. The list of complications is shown in Table 3. Age group did not significantly influence FU complication rates.

Discussion

Our study found that age, ASA status and blood loss were significant co-variates for the occurrence of general complications in spinal stenosis surgery. There was a significant association between the surgery time and the occurrence of surgical complications, but it remains unclear if the complications extend the time of surgery or if their likelihood increases with a prolonged surgery time.

Quoted complication rates in older patients after surgical treatment of LSS range between 2.5 and 80% [5, 24]. Generally, minor complications that do not prolong hospital stay make up the largest part [6, 7, 18, 19, 21, 22]. The wide variation in complication rates is not only based on heterogeneity of patients, operative indications, and surgical procedures performed, but also on the varying definitions of complications per se.

Numerous publications refer to an age-related increase of surgical and general complications [2, 6, 7]. Others found no age related differences. In a retrospective study of 244 patients with LSS between 30 and 87 years treated with laminectomy, Silver et al. reported a complication rate of 22%. The authors found no age-related differences in outcomes [23]. Ragab et al. compared their results from a retrospective analysis of 118 patients (over 70 years of age) with the results in other reports. The authors found a complication rate of 20% and good to very good long-term postoperative results in 92% of patients on an average of 7 years after surgery. They concluded that advanced age is not associated with higher morbidity or mortality and that surgical results and complication rates are comparable between the age groups [19].

The influence of operative technique on complication rates was pointed out by Thomè et al. In his randomized study ($n = 120$) the results from three types of decompression with different extent of bony resection (average patient age 70 years) were compared. There were significantly fewer perioperative complications for patients undergoing bilateral (5%) versus unilateral decompression (17.5%) or laminectomy (22.5%) [24].

Similar to the varying techniques for decompression, use of instrumentation or fusion along with decompression is also discussed as a factor with influence on complication rates. A review study done by Deyo et al. showed that complication rates after fusion were almost twice as high as after open decompression alone [8]. Our study does not confirm this. But interestingly patients of group 3 underwent rigid stabilization and/or fusion less frequently than patients from group 1 ($p = 0.003$) or group 2 ($p = 0.013$) (Table 1), giving rise to the suspicion that complications after rigid stabilization and/or fusion in aged people were feared. The question whether fusion or stabilization accompanying decompression increases the rate of complications in older versus younger patients was already discussed in the literature [5]. Kilincer et al. compared complication rates in younger (<65 years) and older (>65 years) patients ($n = 129$) after posterior decompression (100%) with

Table 3 Surgical, general and follow-up complications in the age groups

	1G:697		2G:583		3G:484		Total:1,764	
Surgical complications	*n*	%	*n*	%	*n*	%	*n*	%
Dura lesion	15	2.2	32	5.5	19	3.9	66	3.7
Other	6	0.9	–	–	1	0.2	7	0.4
Malposition of the implant	5	0.7	–	–	–	–	5	0.3
Wound infection	4	0.6	4	0.7	3	0.6	11	0.6
Bleeding in sp. canal	–	–	1	0.2	2	0.4	3	0.2
Nerve root damage	–	–	1	0.2	1	0.2	2	0.1
Bleeding outside sp.canal	–	–	–	–	1	0.2	1	0.1
Cauda equina dam.	–	–	–	–	1	0.2	1	0.1
Total	30	n.a.	38	n.a.	28	n.a.	96	n.a.
Patient-based rate	30	4.3	37	6.3	26	5.4	93	5.3
General complications								
Kidney/urinary	4	0.6	4	0.7	8	1.7	16	0.9
Other	4	0.6	–	–	3	0.6	7	0.4
Cardiovascular	3	0.4	–	–	8	1.7	11	0.6
Liver/GI	3	0.4	2	0.3	3	0.6	8	0.5
Pulmonary	1	0.1	2	0.3	1	0.2	4	0.2
Cerebral	–	–	2	0.3	1	0.2	3	0.2
Anaesthesiological	–	–	2	0.3	–	–	2	0.1
Total	15	n.a.	12	n.a.	24	n.a.	51	n.a.
Patient-based rate	12	1.7	11	1.9	21	4.3	44	2.5
FU complications								
Sensory disturbance	24	3.4	8	1.4	5	1.0	37	2.1
Recurrence of symptoms	20	2.9	16	2.7	16	3.3	52	2.9
Superficial wound infect	20	2.9	7	1.2	5	1.0	32	1.8
Other	19	2.7	21	3.6	16	3.3	56	3.2
Motor disturbance	19	2.7	4	0.7	4	0.8	27	1.5
Implant failure	7	1.0	13	2.2	4	0.8	24	1.4
Deep subfasc. infect	7	1.0	3	0.5	4	0.8	14	0.8
Malposition of implant	6	0.9	1	0.2	–	–	7	0.4
Internal medicine	4	0.6	3	0.5	5	1.0	12	0.7
Non-union	4	0.6	2	0.3	–	–	6	0.3
Liquor fistula	3	0.4	5	0.9	5	1.0	13	0.7
Spondylitis	1	0.1	4	0.7	1	0.2	6	0.3
Instability	1	0.1	3	0.5	1	0.2	5	0.3
Graft complication	1	0.1	–	–	–	–	1	0.1
Sphincter disturbance	–	–	4	0.7	4	0.8	8	0.5
Disciitis	–	–	3	0.5	–	–	3	0.2
Wrong level	–	–	–	–	1	0.2	1	0.1
Total	112	n.a.	89	n.a.	66	n.a.	267	n.a.
Patient-based rate	79	11.3	60	10.3	49	10.1	188	10.7

n.a. not analyzed

stabilization (94%) or fusion (6%). The surgical complication rates (11%) did not vary significantly, but duration of hospital stay was significantly longer in the older patients [12]. Similarly, Okuda et al. [16] ($n = 101$) showed that clinical outcomes after posterior lumbar interbody fusion (PLIF) did not vary between older (≥70) and younger (<70) patients. Concluding these findings we can state that our results go along with those described in the literature. Rigid stabilization/fusion is feasible even at an older age without a significant increase of surgical or general complications or complications at follow-up, but clearly amplifies the risk of general complications.

The extent of the procedure, i.e. the number of operated segments, is another factor which may influence the rate of complications. In our study, there was no significant influence of number of operated segments on occurrence of complications. Some studies like the one of Carreon et al. [2], identified an operative risk factor increase of 2.4 per fused segment. Cassinelli et al. [3] found a significant association between the long-spanning (≥4 segments) decompression and fusion with major complications. This correlates with the findings of Daubs et al., in a recent study ($n = 46$) of patients over 60 years undergoing complex spine procedures (fusion spanning 5–16 segments, pedicle subtractive osteotomies). They found a higher rate of complications with increasing age [6]. On the other hand, in a study ($n = 20$) of patients in their ninth decade, Raffo et al. identified no correlation between the occurrence of major complications and the number of fused spinal segments.

The current study found no significant difference in the rate of complications at follow-up between the age groups. Age did not influence FU complication rates. Across groups reoccurrence of symptoms (2.9%) was the most frequent complication at follow-up. The reoperation rate described in literature at 4 to 5 years after lumbar spinal surgery ranges between 12–18% of cases, although newer technologies have not led to a decrease [8, 10, 13, 14]. Poorer bone quality in the aged leads to higher rates of malunion, which, however, does not appear to affect clinical results [16]. However, we observed no higher rate of implant related complications in group 3 compared to group 1 and 2 (Table 3). The probability for a reoperation appears to decrease with increasing age [8, 13, 21]. Outcomes described in the literature vary based on length of FU, patient selection, indications, and surgical procedures and present good to excellent results in 53–93% of cases [24]. Our results of the physician-based outcomes show a good or excellent rating in about 80% of cases independently of age (Table 2).

Limitations of the study

Studies based on registry data are classified as Oxford evidence levels 3 contributions. One point of criticism of registry data is unregulated documentation, e.g. selective reporting of only the cases without complications and/or good outcomes, which among other things can influence the complication rates described.

However, statistical comparison of the individual groups here is still valid, since one can assume that the records' accuracy is not influenced by age grouping. One major advantage of registry data is the large case number. Nevertheless, invalid conclusions can result when insufficient attention is paid to issues such as missing data, sources of bias, and data quality. In summary, the current evidence is reasonably weak, and there is a need for higher quality (i.e. randomized, controlled or well-controlled prospective cohort) studies to gain a better analysis on complication risks and effectiveness of spine surgery in the aged.

Conclusions

The "Spine Tango" data pool indicates that the rate of general complications after decompression for LSS is higher in aged patients, but not the rate of surgical complications nor the rate of complications at follow-up.

Additional rigid stabilization/fusion are feasible even in higher age without an obvious rise of surgical or general complications or complications at follow-up. There was no significant influence of number of operated segments on occurrence of complications.

At FU the complication rates showed no age-related variation and physician-based outcome was good or excellent in over 80% in all age groups. Therefore, although we should be aware of the increased risk for general complications in this population, high age (>75) should not be the primary factor for the choice of operative indications and strategy when treating LSS.

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Conflict of interest The authors attest that they have no conflict of interests in the study.

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