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Effects of Age and Co-Morbidities On Complication Rate In Surgical Treatment of Lumbar Degenerative Diseases: A Prospective Clinical Study

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ABSTRACT

Surgery for lumbar degenerative diseases is increasingly more common due to ageing of the population. There were conflicting results on effects of complication rates of ageing and presence of comorbidities in these operations in literature. Presence of systemic co-morbidities, smoking, body mass index (BMI), American Society of Anaesthesiologists score, length of hospital before and after operation and in intensive care unit (ICU), number of decompressed levels (nD), addition of instrumentation, operation time, blood loss, presence of transfusion, surgical and systemic complications seen during the operation and during one month after operation, and requirement of a new operation were recorded in 277 patients (61.6±8.8 years of age, male/female ratio 78/199) operated for lumbar degenerative diseases between 2014 and 2016.

Total 96 out of 277 patients (34.6%) had complications and 1 patient died. The most frequent complications were dural tear (36 cases, 12.9%), wound problems without infection (34 cases, 12.2%), screw malposition (15 cases, 5.4%), and systemic complications (21 cases, 7.5%).

The risk factors were diabetes mellitus (DM) for major complications, BMI and nD for minor complications, and nD for systemic complications. All other factors including age did not affect the complication rate. Regression analyses revealed that the only efficient factor was BMI for presence of overall and minor complications.

It was found that the advanced age did not cause to increase complication rates. The efficient factors for complication rates were DM, BMI and nD.

Keywords: Ageing, complication, comorbidity, lumbar degenerative disease, spinal surgery

Introduction

Lumbar degenerative diseases are increasingly more common seen due to aging of the population. Therefore, requirement of surgery for lumbar degenerative diseases also increases, especially in the elderly patients (1,2). This age group has also frequently some systemic comorbidities such as diabetes mellitus (DM), hypertension (HT), cardiac diseases (CD), lung diseases (LD) and renal diseases (RD).

Operative treatment of lumbar degenerative diseases may more frequently cause various surgical and systemic complications in the elderly patients and the patients with systemic co-morbidities. In literature, there are conflicting results on this condition. Some studies reported that ageing causes increasing the complication rate of the operative treatment of the lumbar

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degenerative diseases (3-6), and others did not (1,2,7-10). Some studies reported more frequent complications in the patients having systemic co-morbidities (1,3,7,11), however other studies reported that they did not cause to increase the complication rate (12,13-15). Most of those studies are in retrospective nature, and Nasser et al reported in a meta-analysis evaluating the complication rate of spinal surgeries that the complication rate is significantly higher in prospective studies than retrospective studies (16).

Because of these conflicting results in literature, we planned a prospective study evaluating and comparing the complication rates of the operative treatment of lumbar degenerative diseases in the patients in different age groups and different systemic conditions.

Material and Methods

The study was approved by local ethics committee of our hospital (2014-194), and an informed consent was signed by all the patients. The patients operated on for lumbar degenerative diseases in the neurosurgery clinic of Bagcilar Training and Research Hospital between March 2014 and December 2016 were planned to be enrolled into the study. Inclusion criteria were: 1-Patients 45 years of age or older, and 2-First operation for lumbar degenerative disease; and exclusion criteria were: 1-Simple lumbar discectomy operations, and 2-Longer stabilizations than 5 segments performed for lumbar degenerative deformity. Total 303 patients according to these criteria were operated in the study period. 28 of them were excluded because they did not accept to participate, therefore, total 277 patients aged ≥45 (mean age and standard deviation (SD) 61.6±8.8, and male/female ratio 78/199) were enrolled into the study, and they were followed for complications during 1 month after the operation.

Presence of systemic co-morbidities (CM), smoking, American Society of Anaesthesiologists (ASA) score, body mass index (BMI), length of stay (LOS) in hospital before and after the operation, requirement of hospitalization in the intensive care unit (ICU), number of the systemic comorbidities (nCM), number of the decompressed segments (nD), requirement of instrumentation, operation time (OT), blood loss during operation, requirement of transfusion, surgical and systemic complications seen during the operation and in one month after the operation, and requirement of reoperation (RRO) in one month were recorded.

The patients were grouped into ten-year periods according to their ages: group 1 (45-54 years), group 2 (55-64 years), group 3 (66-74 years) and group 4 (≥75 years). Also, another age grouping was performed as <75 years and ≥75 years and named as Age Grouping 75 (AG75).

Operations were grouped into two groups as decompression only and instrumentation with or without decompression. The complications were grouped as major (all complications required re-operation, all deep wound infections, all life-threatening systemic complications such as cardiac arrhythmias, gastrointestinal bleeding, and cerebral infarction, all new permanent neurological deficits) and minor complications (other complications). All systemic problems such as myocardial infarction, pneumonia or deep vein thrombosis seen in one month after the operation were recorded as postoperative systemic complications.

The factors affecting the overall, systemic, major and minor complication rates and rate of RRO were evaluated.

Statistical Evaluation: Statistical analyses were performed using PICOS program on E-PICOS website. The conformity of the variables to the normal distribution was examined by the Kolmogorov-Smirnov test. All parametric values were represented by the median and minimum/maximum values because they were without normal distribution. Categorical variables were represented as numbers and percentages. Nominal data were compared with Chi-square test or Fisher's exact test according to the patient numbers in the groups. Parametric data without normal distribution and nonparametric numeric data were compared by Mann-Whitney-U test between two groups and by Kruskal-Wallis test if there were more than 2 groups.

The binary logistic regression analysis was used to identify the significant factors related to rates of various types of complications. For this, the relations between presence of complications and possible predictors were evaluated with Spearman's correlation test and the variables with $p<0.020$ were taken for logistic regression models. Binary regression analyses were performed with these possible variables for each complication groups.

$p<0.05$ was accepted as the statistically significant level.

Results

Two hundred seventy-seven patients aged ≥45 (61.6±8.8 mean±SD, and male/female ratio 78/199) were enrolled into the study. The male patients were significantly older than the female patients (for male and female patients were 64.5 (46-88) and 61 (46-91) (median with min. max.), respectively, p=0.039) (Table 1). However, distribution of the age groups of both genders was not statistically significant (p=0.077).

Co-morbidities: The systemic co-morbidities, ASA scores and BMI of the patients were given in the Table 1. The rates of CD and smoking were significantly higher in the male patients than the female patients (p<0.0001 for both). The rates of HT, DM, CD and RD significantly increased (p<0.0001, p=0.022, p<0.0001, p<0.0001) and the rate of smoking was significantly decreased by age (p=0.012).

The number of the systemic co-morbidities (nCMs) was 0 to 4 (median 1) and the classes of the ASA were 1 to 3 (median 2) for all patients. The ASA score and the nCM were not statistically different between the genders (p=0.511 and p=0.349, respectively). However, both were significantly increased by age (p<0.0001 for both) (Table 1). In two group comparisons, they both were significantly different between all age groups except between 65-74 and ≥75 age groups.

The BMI of the patients was 29.2 (18.7-48.2) (median with min.-max.). It was significantly higher in the female patients than the male patients (p=0.044), however, it was not statistically different between age groups (p=0.242) (Table 1).

The Operations: Only decompression was performed in 104 patients, and instrumentation was added in 173 patients (Table 2). In the female patients, instrumentation rate was significantly higher than the male patients (67.8% versus 48.7%, p=0.003). The instrumentation rate was also significantly different between age groups (57.9%, 73.7%, 56.8% and 47.6% for the age groups 1, 2, 3 and 4, respectively, p=0.028). It was significantly higher in the 55-64 age group than the other groups (Table 2).

The nD in all patients was between 0 to 5 levels (median 1). It had similar distribution in the female and male patients (p=0.65). However, it significantly differed between age groups (p=0.019) and it was significantly lesser in the youngest age group (Table 2).

Operation time was between 45 and 460 minutes (180 (45-460) as median with min.-max.), and blood loss during operation was between 0 and 2300 ml (469±442 as median with min.-max). 64 patients were required blood product transfusion, and the number of the package of transfusion was between 0-8 (median 0). OT and requirement of transfusion was not different according to the gender and age group (p=0.695 and p=0.678 for OT and p=0.056 and p=0.114 for transfusion, respectively). Blood loss during operation was significantly higher in the female patients than the male patients possibly due to the higher instrumentation rate in women (350 (0-2300) and 250 (0-2000) ml, median with min.-max, respectively, p=0.012), but it was not significantly different between age groups (p=0.270) (Table 2).

Hospitalization: Length of stay in hospital before and after operation were 3 (0-31) and 3 (1-27) (median with min.-max.) for all patients. 32 patients were also required hospitalization in the ICU for one or two days. Preoperative LOS was not significantly different between genders or age groups. However, postoperative LOS was significantly longer in the female patients (p=0.012) possibly due to the higher rate of instrumentation. The rate of requirement of hospitalization in the ICU was higher in older patients (p<0.0001) (Table 2).

Preoperative and postoperative LOS were significantly different between the patients who had instrumentation and the ones with only decompression (4 (0-20) and 2 (0-31) days, respectively, for preoperative LOS, and 4 (1-27) versus 1 (1-10) days, respectively, for postoperative LOS, p<0.0001 with Mann-Whitney U test for both).

Complications: There were complications in 96 out of 277 patients (34.6%) and there were more than one complication in some patients. The rate of presence of systemic complications in all patients was 7.2% (21 complications in 20 patients). There were 27 major complications in 26 patients (9.3%) and 85 minor complications in 75 patients (27%). The list of the complications was given in Table 3. Also, the rates of complications according to the age groups, genders and operation groups were shown in Figures 1 and 2.

The most common complications were dural injury (12.9%) and wound problem without infection (8.3%). Screw malposition was found in 15 patients (8.6%) and 10 of those screws were revised due to clinical findings or possible biomechanical effects in future. Wound infection

Table 1a: Demographic Data, Co-Morbidities of The Patients According To Gender and Age Groups

		HT (n/%)	DM (n/%)	CD (n/%)	LD (n/%)	RD (n/%)	S (n/%)
All		162/58.4	97/35	40/14.4	46/16.6	20/7.2	16.9
Sex	M	46/59	25/32	21/26.9	16/20.5	2/2.5	29/37.2
	F	116/58.3	72/36.2	19/9.5	30/15	12/6	18/9
	p	0.917b	0.517b	<0.0001b	0.274b	0.300c	<0.0001b
Age Group	1	24/34.7	15/21.7	2/2.9	6/8.7	0/0	19/27.5
	2	53/53.5	37/37.4	11/11.1	14/14.1	3/3	16/16.2
	3	68/77.3	38/43.2	19/21.6	21/23.9	7/7.9	8/9.1
	4	17/80.9	7/33.3	8/38.1	5/23.8	10/47.6	4/19
	p	<0.0001a	0.022a	<0.0001a	0.051a	<0.0001a	0.012a

The significant p values were marked as bold characters; [a]: Mann-Whitney U test; [b]: chi-square test; c: Fisher's exact test; CD: cardiac disease; DM: diabetes mellitus; F: Female; HT: hypertension; LD: lung disease; M: Male; RD: renal disease; S: smoking

Table 1b: Demographic Data, ASA Scores and BMI of the Patients According To Gender and Age Groups

		nCM 0/1/2/3/4 (%)	ASA 1/2/3 (%)	BMI	Sex M (n/%)	Age*
All		24.2/34.7/23.8/12.3/5	32.9/53.4/13.7	29.2 (18.7-48.2)		61 (45-91)
Sex	M	21.8/32/28.2/10.3/7.7	33.3/47.5/19.2	27.4 (18.7-34)		64.5 (46-88)
	F	25.1/35.7/22.1/14.1/4	32.7/55.8/11.5	30.1 (19.5-48.2)		61 (46-91)
	p	0.349a	0.511b	0.044a		0.039a
Age Group	1	45/36.2/15.9/2.9/0	62.3/34.8/2.9	29.3 (22.3-44.2)	21/26.2	
	2	25.3/38.4/20.2/13.1/3	35.4/54.5/10.1	29.5 (19.5-42.9)	26/24.7	
	3	11.4/30.7/30.7/17/10.2	12.5/65.9/21.6	28.9 (19.1-48.2)	25/32	
	4	4.8/28.6/38.1/19/9.5	9.6/57.1/3.3	27.6 (20.7-33.2)	6/42.8	
	p	<0.0001c	<0.0001c	0.242c	0.077a	

The significant p values were marked as bold characters; *median (min-max) because parameters were not normally distribute; [a]: Mann-Whitney U test; [b]: chi-square test; [c]: Kruskal-Wallis test; ASA: American Society of Anesthesiologist, BMI: body mass index; M: Male; n: number; nCM: number of complications

was found in 11 patients (3.9%) and other systemic infections were in 13 patients (4.6%) (Table 3). The infection rates of 45-54, 55-64, 65-74 and ≥75 years age groups were 5.8%, 2%, 6.8%, and 5%, respectively. Ages of the patients with and without wound infection were not statistically different (59 (47-68) and 62 (45-91), median with min.-max., respectively, p=264 with Mann-Whitney U test).

Reoperations: In 22 patients, 24 reoperations were required (Table 3). 10 of them were revision of malpositioned screws, 5 were debridement of wound infection, 3 were performed for CSF fistula (2 open repair, and 1 lumbar drainage), 3 were re-decompression for inadequate decompression in first operation, 1 for wound problem without infection, 1 was stabilization for postoperative instability, and the last one was injection for postoperative meralgia paresthetica.

Effects of the variables on presence of complications: None of the evaluated factors including age, age group (for both grouping systems), gender, ASA score, BMI, presence of HT, DM, CD, LD, RD, smoking, nCM, LOS before operation, OT, amount of blood loss during operation, requirement of transfusion of blood products and requirement of ICU hospitalization were statistically different between the patients with and without overall complications (Tables 4, 5 and 6).

Presence of DM was significantly higher in the patients with major complications (p=0.015), BMI

Table 2: Operation and Hospitalization Variables of The Patients According To Gender and Age Groups

		PrLOS (day)*	PoLOS (day)*	ICU (%)	OT (min)*	Blood loss (ml)*	T (%)	I (%)	nD*
All		3 (0-31)	3 (1-27)	11.6	180 (45-460)	350 (0-2300)	23.1	62.5	1 (0-5)
Sex	M	3 (0-31)	3 (1-8)	15.4	180 (45-390)	250 (0-2000)	15.4	48.7	1 (0-5)
	F	3 (0-20)	3 (1-27)	10.1	180 (50-460)	350 (0-2300)	26.1	67.8	1 (0-4)
	p	0.479a	0.012a	0.212b	0.695a	0.012a	0.056b	0.003b	0.650a
Age Group	1	3 (0-20)	3 (1-10)	2.9	180 (50-350)	300 (0-2000)	13	58	1 (0-3)
	2	3 (1-18)	4 (1-27)	5.1	180 (45-460)	400 (0-2300)	27.3	73.7	1 (0-4)
	3	3 (0-31)	4 (1-10)	20.5	180 (60-390)	350 (0-2000)	27.3	56.8	2 (0-4)
	4	3 (0-11)	3.8±2.3	33.3	180 (90-350)	350 (20-1500)	19	47.6	2 (0-5)
	p	0.467c	0.052c	0.000a	0.678c	0.270c	0.114a	0.028a	0.019c

The significant p values were marked as bold characters; *median (min-max) because parameters were not normally distribute; [a]: Mann-Whitney U test; [b]: chi-square test; [c]: Kruskal-Wallis; I: Instrumentation; ICU: intensive care unit; nD: number of decompressed levels; OT: operation time; PoLOS: Postoperatiive length of stay; PrLOS: preoperative length of stay; T: transfusion

Table 3: List of the Complications

Complication	n of the patients	%
Dural injury	36	12.9
Wound problem without infection	23 (opening, hemorrhagic flux, CSF fistula, local allergic reaction; 1 reoperation for wound opening, 3 for CSF fistula)	8.3
Wound infection	11 (10 superficial, 1 deep; 5 reoperation in 4 patients)	3.9
Other infections	13 (9 urinary, 2 respiratory, 2 unexplained fever)	4.6
Screw malposition	15 (with 10 revisions)	8.6*
Other systemic complications	9 (2 delirium, 1 each aritmia, hematuria, chest pain, GIS hemorrhage, asthmatic crisis, cerebral infarction, cardiac arrest)	3.2
Inadequate decompression	3 (reoperation in all)	1
New neurological deficits	2 (leg paresis, urinary incontinence, both transient)	0.7
Neuropathic pain	2	0.7
Meralgia paresthetica	2 (1 injection)	0.7
Spinal instability	1 (with reoperation)	0.3
Overall complications	96 patients	34.6
Major complications	27 in 26 patients	9.3
Minor complications	85 in 75 patients	27
Systemic complications	21 in 20 patients	7.2
Reoperations	24 reoperations in 22 patients	7.9

*The rate in 173 patients underwent instrumentation

and nD were significantly higher in the patients with minor complications (p=0.003, and p=0.020, respectively), and nD was also significantly higher in the patients with systemic complications (p=0.024) (Tables 5 and 6). BMI was not significantly different between the patients with and without wound infection (p=0.896) and with and without wound problems (p=0.977).

Postoperative LOS was significantly longer in the patients with overall, systemic and minor complications as to be expected (p=0.001, p=0.005 and p=0.004, respectively), but not with major complications (Table 6). Any variables had not a significant effect on RRO (Tables 5 and 6, and Figure 2).

In the patients underwent decompression and instrumentation, the rate of major complications (10.9% versus 6.7%) and RRO (10.4% versus 3.8%) were quite higher than to be in the patients with only decompression probably due to revision of malpositioned screws, however the differences

Table 4a: Relationships of Presence of Complications With Demographic Characteristics

		Gender M/F (%)	Age*	Age Group 1/2/3/4 (%)
OC	C-	28.7/71.3	61 (46-91)	24.4/38.1/29.8/7.7
	C+	27.1/72.9	62 (46-83)	26/31.3/35.4/7.3
	p	0.772b	0.996a	0.747a
SC	C-	27.6/72.4	60.5 (46-91)	24.5/37/31.1/7.4
	C+	35/65	66 (50-82)	30/20/40/10
	p	0.480b	0.701a	0.670a
MjC	C-	28.3/71.7	61 (45-91)	24.3/36.7/31.1/7.9
	C+	26.9/73.1	61 (46-80)	30.8/26.9/38.5/3.8
	p	0.883b	0.812a	0.768a
MnC	C-	28.7/71.3	61 (46-91)	25.2/37.1/30.2/7.4
	C+	26.7/73.3	62 (45-83)	24/32/36/8
	p	0.737b	0.665a	0.478a
RRO	-	29/71	62 (46-91)	24.3/36.1/31.4/8.2
	+	18.2/81.8	60 (46-70)	31.8/31.8/36.4/0
	p	0.333c	0.330a	0.415a

The significant p values were marked as bold characters; *median (min-max) because parameters were not normally distribute; [a]: Mann-Whitney U test; [b]: chi-square test; [c]: Fisher's exact test; C: complication; MjC: Major complications, MnC: Minor complications; OC: Overall complications; RRO: requirement of reoperation; SC: Systemic complications

Table 4b: Complication Rates For Genders and Age Groups

		OC n/%	SC n/%	MjC n/%	MnC n/%	RRO n/%
All		96 (34.6)	20 (7.2)	26 (9.3)	75 (27)	22 (7.9)
Sex	M	26 (33.3)	7 (8.9)	7 (8.9)	20 (25.6)	4 (5.1)
	F	70 (35.1)	13 (6.5)	19 (9.5)	55 (27.6)	18 (9)
Age Group	1	25 (36.2)	6 (8.6)	8 (11.5)	18 (26)	7 (10.1)
	2	30 (30.3)	4 (4)	7 (7)	240 (24.2)	7 (7)
	3	34 (38.6)	8 (9)	10 (11.3)	27 (30.6)	8 (9)
	4	7 (33.3)	2 (9.5)	1 (4.7)	6 (28.5)	0 (0)

The significant p values were marked as bold characters; F: female; M: male; MjC: major complication; MnC: minor complication; n: number; OC: overall complication; RRO: requirement of reoperation; SC: systemic complication

were not significant (p=0.240 and p=0.051, respectively) (Figure 1).

Regression Analyses: For various complication groups (overall, systemic, major, and minor complications and RRO), all variables were correlated with Spearman correlation test to find the significantly efficient variables. The p value was <0.20 in AG75, BMI, nD and OT for overall complications; in ASA, nD, OT and blood loss for systemic complications, in nCM, DM and RD for major complications, in AG75, BMI, smoking, ASA, ICUH, nD, and OT for minor complications; and nCM, DM, LD, RD, ASA, presence of stabilization, blood loss and transfusion for RRO. Binary regression analyses were performed with these determined variables for presence/absence of overall, systemic, major, and minor complications and RRO. The only significant variable was the BMI for overall and minor complications in binary analyses (p= 0.033 and p=0.010, respectively). There was not a significant variable for systemic and major complications and RRO.

Discussion

Requirement of surgical treatment of lumbar degenerative diseases increases with ageing of

Table 5a: Relationships of the Presence of Complications With Comorbidities

		HT (n/%)	DM (n/%)	CD (n/%)	LD (n/%)	RD (n/%)	S (n/%)
	C-	107/59.1	67/37	24/13.3	31/17.1	14/7.7	34/18.7
OC	C+	55/67.3	30/31.3	16/16.7	15/15.6	6/6.2	13/13.5
	p	0.770a	0.338 a	0.443 a	0.749 a	0.650 a	0.269 a
	C-	152/59.1	90/35	36/14	42/16.3	18/7	42/16.3
SC	C+	10/50	7/35	4/20	4/20	2/10	5/25
	p	0.424 a	0.999 a	0.505b	0.754b	0.645b	0.320 a
	C-	149/59.4	85/33	37/14.7	43/17.1	19/7.5	42/16.7
MjC	C+	13/50	12/60	3/11.5	3/11.5	1/3.8	5/19.2
	p	0.785b	0.015a	1b	0.589b	0.705b	0.747 a
	C-	117/57.9	70/34.6	26/12.9	34/16.8	15/7.4	38/18.8
MnC	C+	45/60	27/36	14/18.7	12/16	5/6.6	9/12
	p	0.755 a	0.835 a	0.223 a	0.869 a	0.828a	0.180 a
RRO	-	150//58.8	93/36.4	38/14.9	45/17.6	20/7.8	44/17.2
	+	12/54.5	4/18.2	2/9.1	1/4.5	0/0	3/13.6
	P	0.696a	0.104b	0.751b	0.142b	0.383b	1b

The significant p values were marked as bold characters; [a]: chi-square test; [b]: Fisher's exact test; C: complication; CD: cardiac disease; DM: diabetes mellitus; HT: hypertension; LD: lung disease; MjC: Major complications, MnC: Minor complications; OC: overall complications; RD: renal disease; RRO: requirement of reoperation; S: Smoking; SC: Systemic complications

Table 5b: Relationships of the Presence of Complications With ASA Score and BMI

		nCM 0/1/2/3/4 (%)	ASA 1/2/3 (%)	BMI*
	C-	21/38.1/22.1/13.3/5.5	33.7/53/13.3	28.8 (19.5-49.2)
OC	C+	30.2/28.1/27.1/10.4/4.2	31.2/54.2/14.6	29.3 (18.7-42.9)
	p	0.340a	0.900b	0.012a
	C-	61/93/56/33/14	33.9/53.3/12.8	29.1 (19.5-48.2)
SC	C+	30/15/50/5/0	20/55/25	30 (18.7-40)
	p	0.957a	0.213b	0.464a
	C-	22.3/35.4/24.7/12.4/5.2	31.5/55.4/13.1	29.2 (18.7-48.2)
MjC	C+	42.3/26.9/15.4/11.5/3.9	46.2/34.6/19.2	29.2 (19.5-41.6)
	p	0.090a	0.130b	0.904a
	C-	23.3/37.6/20.8/12.9/54.4	35.6/51/13.4	29.4 (18.7-49.2)
MnC	C+	26.7/26.7/32/10.6/4	25.3/60/14.7	27.7 (20-44.1)
	p	0.810a	0.165b	0.003a
RRO	-	22.7/34.9/24.7/12.6/5.1	31.4/54.9/13.7	29.2 (18.7-48.2)
	+	40.9/31.8/13.6/9.1/4.6	50/36.4/13.6	29.1 (21.4-42.9)
	p	0.089a	0.263b	0.660a

population and these operations have quite high complication rates. Complication rates in a wide range were reported in literature. Although, quite low rates are reported in some clinical series, overall complication rate is higher than 50% in others, especially in prospective studies (17). Even higher rates may be expected in elderly patients probably because of their usual poor conditions and frequent additional systemic comorbidities. In the series including the patients older than 65 years old by Carreon et al (18), the rate of presence of co-morbidities requiring medical treatment was 88%, and the overall complication rate was reported as 73.5%.

Table 6: Relationships of The Presence of Complications With Hospitalization and Operation Variables

		PrLOS days*	PoLOS days*	ICU (%)	OT min*	Blood loss, ml*	T (%)	I (%)	nD**
OC	C-	3 (0-31)	3 (1-10)	9.9	180 (45-450)	300 (0-2300)	22.7	61.3	1 (0-5)
	C+	3 (0-20)	4 (1-27)	14.6	180 (50-460)	375 (0-2000)	24	64.6	2 (0-4)
	p	0.765a	0.001a	0.25b	0.142a	0.442a	0.806b	0.605b	0.106a
SC	C-	3 (0-31)	3 (1-27)	10.9	180 (45-460)	300 (0-2300)	23	61.9	1 (0-5)
	C+	3 (1-18)	4 (1-10)	20	180 (90-380)	400 (50-1800)	25	70	2 (1-4)
	p	0.650a	0.005a	0.265c	0.056a	0.083a	0.835b	0.469b	0.024a
MjC	C-	3 (0-31)	3 (1-27)	11.6	180 (45-450)	300 (0-2300)	22.3	61.4	1 (0-5)
	C+	4 (0-20)	4 (1-10)	11.5	180 (90-300)	450 (0-2000)	30.8	73.1	1 (0-4)
	P	0.243a	0.079a	1c	0.705a	0.321a	0.330b	0.240b	0.528a
MnC	C-	3 (0-31)	3 (1-10)	10.4	180 (45-450)	310 (0-2300)	24	65.1	1 (0-5)
	C+	3 (0-20)	4 (1-27)	16	180 (50-460)	350 (0-2000)	24	64	2 (1-4)
	p	0.628a	0.004a	0.158b	0.051a	0.510a	0.829b	0.746b	0.020a
RRO	-	3 (0-31)	3 (1-27)	11.8	180 (45-460)	300 (0-2300)	22	60.8	1 (0-5)
	+	4 (1-20)	5 (1-14)	9.1	180 (100-300)	500 (0-2000)	36.4	81.8	1 (0-4)
	p	0.053a	0.106a	1c	0.479a	0.107a	0.124b	0.065c	0.421a

The significant p values were marked as bold characters; *median (min-max) because parameters were not normally distribute; [a]: Mann-Whitney U test; [b]: chi-square test; [c]: Fisher's exact test; C: complication; I: Instrumentation; ICU: Intensive care unit; MjC: Major complications, MnC: Minor complications; nD: number of decompressed levels; OC: Overall complications; OT: operation time; PoLOS: Postoperatiive length of stay; PrLOS: preoperative length of stay;; RRO: requirement of reoperation; SC: Systemic complications

There were conflicting results on complication rates in various age groups of these operations in literature. Some studies reported more frequent complications in elderly patients than to be in younger patients. In a prospective study by Glassman et al, overall complication rate was 31.7% in the patients older than 65 years old whereas it was 11.8% in younger ones (4). Imajo et al (5) reported that the patients with perioperative complications were significantly older than the patients without complications in a nationwide survey on complications from spine surgery in 2011. Marbacher et al (6) reported a higher medical complication rate in older (≥65<80y) and geriatric (≥80y) patients than to be in younger patients (17.5%, 13.4% and 7%, respectively). On the other hand, Jo et al (7) did not find a significant difference in complication rates between the patients older and younger than 65 years. Rihn et al (2) compared the complication rates of the patients older and younger than 80 years in a reevaluation of the SPORT study, and they did not find differences for perioperative complication, reoperation and mortality rates. Nanjo et al (9) also reported no differences in complication rates between the patients older and younger than 80 years underwent decompression for lumbar degenerative diseases.

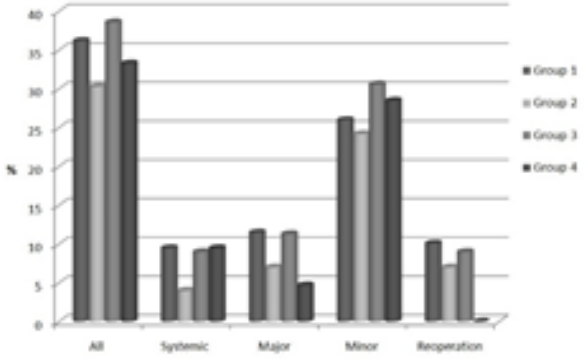

Fig. 1. The graphic showes the rates of various types of complications and requirement of reoperation for the age groups

In our prospective clinical series, overall, systemic, major and minor complication rates were 34.6%, 7.2%, 9.3% and 27%, respectively in 277 patients aged between 45 to 91 years old, and there were not significant differences between age groups. The systemic complication rate increased with ageing, and the highest rate was in the oldest group (9.5%), however, the differences were not

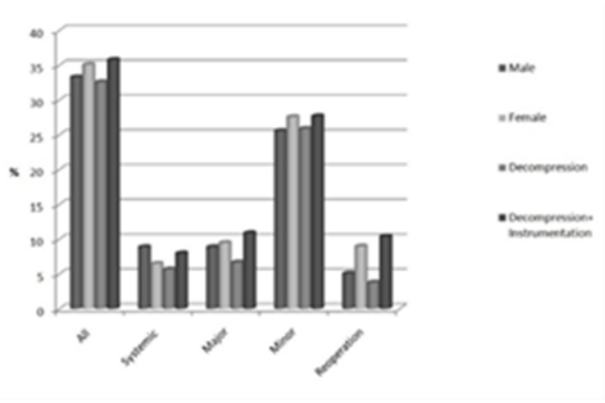

Fig. 2. The graphic showes the rates of various types of complications and requirement of reoperation for genders and operation groups

significant. Carreon et al (18) reported the most common complication in elderly patients was wound infection, and its incidence in those age groups was 10%. However, we did not find a significant difference between wound infection rates in various age groups.

Contradictory results for complication rates were also reported in the patients with and without systemic comorbidities in literature. Some authors reported that presence of comorbidities did not affect the complication rates (12,18), however, others reported that it affected (7,19,20). Li et al (20) found that number of comorbidities was an important factor on presence of complications.

Especially DM was reported an important risk factor increasing complication rate in some studies (19). However, Bendo et al (12) did not find any effects of DM on complication rate in lumbar fusion surgery. Patient's ASA score is a reliable marker for general status of the patient, and it was found as a significant factor on complication rate of spinal surgery in some studies (10,21,22).

One of the most studied parameters as a risk factor for increasing complication rate, especially rate of postoperative infection in spinal surgery is obesity (23-25). However, contradictory results were reported in some series. For example, Yadla et al (15) reported in a series including 87 patients older than 65 years old that obesity did not cause to higher complication rates. Similarly, Imajo et al (5) reported in a nationwide survey with more than 24,000 patients that the mean BMI was not different in the patients with and without intraoperative and postoperative complications. Shamji et al (26) reported in another nationwide study consisting nearly 250,000 patients that obesity caused to significantly higher rate of wound complications and infection but did not to other complications.

In our series, only DM was a risk factor for presence of major complications, and BMI for presence of minor complications. BMI was also found as a significant risk factor for presence of overall and minor complications in regression analyses. Although increasing ASA scores caused to increased rates of complications, the differences were not significant.

Poor bone quality also affects outcome of the surgery in elderly patients and may cause increase of the rate of late complications such as instrumentation failure or pseudoarthrosis. However, we did not evaluate osteoporosis as a risk factor because this study focused on the early complications occurring in one month after operation.

Some variables related to the operation such as nD, addition of instrumentation to decompression, OT, blood loss and blood product transfusion also may be affected the complication rates. Especially addition of instrumentation was reported an important factor causing increase of complication rate. This may not be surprised because instrumentation has own perioperative complications on one hand and it also causes to increase OT, intraoperative blood loss and requirement of transfusion on the other hand. Deyo et al (27) reported that the rate of life-threatening complications increased 2.5 times in the patients underwent instrumentation instead of only decompression, and Imajo et al (5) reported 2 times more complications in the patients underwent instrumentation than to be in the patients underwent only decompression. Transfeldt et al (28) reported in an elderly patient series with degenerative scoliosis that complication rates were 10%, 40%, and 56% in the patients underwent decompression, decompression with limited fusion or decompression with long segment fusion, respectively. Watanabe et al (10) reported in a series including elderly patients older than 80 years of age that instrumentation caused to significantly more frequent minor complications. However, there are also some series reported that addition of instrumentation did not increase the complication rate in literature (22,29-31).

In our series, addition of instrumentation to decompression did not cause significant increase of complication rate as to be in our previous retrospective case series including 75 elderly patients (31). Logistic regressions also revealed that instrumentation was not a risk factor for presence of overall, systemic, major and minor complications.

Longer OT and higher blood loss during operation were reported as risk factors for presence of complications in some series. Mahesh et al (32) reported in a OT and blood loss were significantly higher in complicated patients. Carreon et al (18) also found that the complication rate increases with increased blood loss and longer OT. Watanabe et al (10) reported that OT longer than 180 minutes and instrumentation were risk factors for presence of minor complications in multivariate analyses. Wang et al found that OT and blood loss were significant risk factors for postoperative spinal infection (33).

Yadla et al (17) found in a spinal surgery series with various diagnoses that LOS in the hospital of the patients with minor complication was significantly longer than to be in the patients without minor complications, and even in the patients with major complications. In our series also, LOS after operation was significantly longer in the patients with overall, minor and systemic complications, but not in the patients with major complications. This was probably due to that the most frequent minor complication was wound problem with or without infection, and the patients with wound problem was hospitalized till to their wound healing. In our study, povidone-iodine sterilization, the effect of which has been shown before, was applied to prevent infections, which is a factor that prolongs the length of stay (34).

Requirement of a second unplanned operation after spinal surgery causes to reduce quality of life, to add new risks of morbidity and mortality to the patient and to increase the cost of the treatment. Tsai et al (35) reported that unplanned revision surgery rate was 1.12% in a week after elective spinal surgery in a large series including more than 10,000 patients. This rate was 5.5% for thoracolumbar spine and 8% for lumbar spine and most of those operations were performed due to screw malposition and inadequate decompression. In our series, the reoperation rate was 7.9% in 1 month, and screw revision was the most common cause. Screw malposition rate was 8.6% out of 173 patients underwent instrumentation in our series, and 10 out of 15 malpositioned screws were revised. In the study by Guigui et al (11), the most common cause of revision surgery was inadequate decompression. In our series, only 3 patients (1%) were required a second decompression surgery and, the first surgery was only decompression in all of them. Tsai et al (35) reported two times higher reoperation rate for inadequate decompression in the patients underwent decompression only than to be in the patients underwent instrumentation.

Dural injury is usually the most frequently reported complication in lumbar spinal surgery and its incidence was 2.1-14% in literature (5,18,36, 37). In our series, the most frequent complication was also dural injury (36 patients, 12.9%). However, only 3 patients (8.3%) had postoperative CSF fistula and external lumbar drainage or open repair was required in those patients.

In this study, the significantly efficient factors on presence of various types of postoperative complications in the patients operated for lumbar degenerative diseases were DM, BMI and nD, and the only factor found in regression analyses was BMI. Age and co-morbidities other than DM did not affect the complication rates. Addition of instrumentation to decompression caused to increase the complication and reoperation rates however the differences were not significant.

Prospective nature of this study provides to increase its reliability. However, small number of the elderly population according to the younger age groups is an important limitation although total number of the series was quite high. To plan new studies including much more elderly patients may provide valuable new data.

Our study revealed that age did not significantly affect the complication rates of posterior spinal surgery for lumbar degenerative diseases. Presence of DM, higher BMI and nD were found as efficient factors. Therefore, we thought that it is not necessary to avoid spinal surgery in elderly patients because of their age if a surgery is indicated. However, obesity and DM are important risk factors, and the complication rates may be lessened if they are controlled preoperatively in the patients in all age groups. This study may contribute to changing negative prejudices about spinal surgery in the elderly.

Conflicts of Interest: There is no conflicts of interest.

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