The Impact of Gender on Post-Operative Length of Stay after Lumbar Decompression Fusion Surgery Referable to Possible Comorbidity Factors

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Introduction

Proportionally more healthcare dollars are devoted to the care of females than their male counterparts (Lassman, Hartman, Washington, Andrews, & Catlin, 2014); rightfully so, as females have a greater life expectancy and a special reproductive burden (Owens, 2008; Vaidya, Gautam, & Karmakar, 2012). In neurosurgery, some controversy exists as to the influence of gender on prolonging hospital stay, particularly following operative intervention for spinal column difficulties (Table 1). To clarify such issues we conducted the following study.

Methods

A retrospective review of the clinical course of all patients that underwent elective lumbar spinal fusion procedures by five neurosurgeons between October 2010 and November 2013 at The Georgia Neurosurgical Institute was undertaken. Comorbidities, complications, and other relevant general variables were obtained. Comorbidities which included twenty four variables relating to preexisting diseases were collected from patients' past medical histories and their preoperative evaluation visit forms (Table 2). Complications were twelve secondary medical problems that developed during hospital stays that were not existent prior to the operation (Table 3). Other collected variables contained age, gender, race, Length of hospital Stay (LOS), Body Mass Index (BMI), and nine others (Table 4). LOS was measured from the day of procedure until the time of discharge (up to the first decimal of a day). As our patient's sample is relatively small in size, we chose to exclude those outliers who stayed more than 4 standard deviations above the mean length of stay (>25.3 days). There were only 4 patients that fell into this category.

A simple t-test was used to study the mean gender difference

in LOS. Then, the variables that showed more prevalence in one gender were identified using chi-squared analysis. Finally, each gender cohort was statistically studied separately in order to identify which variables lead to a prolonged LOS in each gender using multivariate linear regression analysis. SPSS-19 software was used to perform all statistics.

Results

A total number of 334 patients were assessed. The mean $\pm$ SD

Table 1: Review of articles published in Pub Med since January 2013 about the impact of gender on length of stay in Spine Procedures.

Paper	Year	Study Sample Underwent	Gender related result
Herren et al.17	2014	Posterior lumbar spine fusion procedures	Male gender was a factor prolonged LOS
Schoenfeld et al.18	2013	Spine trauma	Male gender was a predictor for higher mortality and higher complication rate
Alosh et al.19	2015	Anterior cervical spine surgery	Male gender was an independent predictor of hospital charges and LOS
Kelly et al.20	2014	Surgical correction of spondylolisthesis	Female gender was a factor prolonged LOS
Yoshihara et al.21	2014	Surgical treatment of thoracic disc herniation	Female gender was a risk factor for mortality
Sharma et al.22	2014	Spinal cord tumor surgeries	Female gender was an independent predictor of adverse discharge disposition but not to higher costs
Wait et al.23	2013	Cervical or Lumbar spinal fusions	Gender did not show any impact on LOS

length of stay was 5.68 ± 4.9 days. After taking out 4 patients who stayed for more than 25.3 days (4 SDs above the mean LOS), the mean was found to be 5.3 ± 3.4 days. The remaining 330 patients were divided into 190 females and 140 males (see tables 1, 2, and 3 for a detailed description). Females stayed for 1 day longer than males ($F=5.7 \pm 3.1$, $M=4.7 \pm 3.7$; $P=0.008$).

A history of coronary artery disease was the only variable that showed more prevalence in the male cohort ($P=0.041$). However, variables that were more prevalent in the female cohort were postoperative anemia severity ($P<0.001$), vitamin D deficiency ($P=0.014$), diabetes mellitus ($P=.05$), hypothyroidism ($P=0.005$), anxiety disorders ($P=0.002$), major depressive disorder ($P=0.001$), obesity ($BMI>30$, $P=0.013$), hypotension ($P=0.029$), severe postoperative respiratory problems ($P=0.055$), and postoperative psychiatric symptoms ($P=0.045$).

Variables that showed a significant impact on LOS in the male cohort were postoperative anemia ($P=0.033$), number of operated levels ($P=0.053$), developing postoperative infections ($P=0.012$), postoperative pulmonary embolism ($P=0.008$), and

Table 2: The Collected Co morbidities.

	All patients	Males	Females
Preoperative Anemia (Y/N)	30.0%	30.2%	29.4%
Myocardial Infarction	3.7%	4.3%	3.2%
Coronary Artery Disease (other than MI)	11.0%	15.0%	7.9%
Congestive Heart Failure	1.5%	1.4%	1.6%
Arrhythmias	4.8%	5.7%	4.2%
Hypertension	66.1%	63.6%	67.9%
Respiratory Disorders (other than sleep related)	26.2%	23.0%	28.6%
Chronic Obstructive Pulmonary Disease	11.6%	12.2%	11.1%
Sleep Apnea	10.4%	12.9%	8.5%
Chronic Constipation	14.2%	12.9%	15.3%
Peptic Ulcer Disease	2.7%	2.1%	3.2%
Renal Failure	2.1%	1.4%	2.6%
Diabetes Mellitus	30.0%	24.3%	34.2%
Hypothyroidism	18.6%	11.5%	23.8%
Stroke	5.5%	4.3%	6.3%
Transient Ischemic Attack	1.8%	0.7%	2.6%
Seizure	2.1%	0.7%	3.2%
Neuromuscular Disorders	1.8%	1.4%	2.1%
Memory Loss	5.5%	3.6%	6.8%
Anxiety Disorders	20%	12.1%	25.8%
Major Depression	26.1%	16.4%	33.2%
Arthritis	58.8%	61.4%	56.8%
Obesity ($BMI \geq 30$)	57.1%	49.3%	63.0%
Morbid Obesity ($BMI \geq 40$)	10.6%	10.0%	11.1%
Total Comorbidities	5.8	5.4	6.1

Table 3: The Collected Complication.

		All patients	Males	Females
Postoperative Anemia Severity	No anemia (≥12 in f. / ≥13.5 in m.)	4.6%	5%	4.3%
	Mild Anemia (<12 in f. / <13.5 in m. to ≥10)	32.3%	51.8%	17.7%
	Moderate (<10 to ≥8)	39.1%	32.4%	44.1%
	Severe (<8)	24%	10.8%	33.9%
Dural Tear/CSF Leak		3.4%	1.4%	4.7%
Fever		24.7%	20.3%	22.6%
Infections (total)		12.2%	9.4%	14.2%
Urinary Tract Infection		3.7%	2.2%	4.7%
Wound Infection		2.4%	2.2%	2.6%
Respiratory Complaints		7.0%	5.8%	7.9%
Pulmonary Embolism		1.2%	2.2%	0.5%
Urinary Retention		2.4%	1.4%	3.2%
Postoperative Psychiatric Symptoms (e.g. hallucination, delirium)		3.0%	0.7%	4.7%
Constipation		12.5%	9.4%	14.7%
Total Number of Complication		2.2	2.1	2.2

postoperative glucose intolerance ($P=0.045$). However, variables that showed a significant impact on LOS in the female cohort were postoperative anemia severity ($P=0.029$), developing postoperative urinary retention ($P=0.006$), postoperative respiratory complications ($P=0.006$), spinal dural tear ($P<0.0001$), and neuromuscular disorders ($P=0.005$).

Discussion

Our study demonstrated that females have more comorbidities than males which might be referable to the different hormonal structures between genders. Our study also recognized that the variables that influence LOS in each gender cohort are different. However, age did not show an independent influence on LOS in either of the genders, despite females being significantly older than males in our study. Recognizing this age disparity, statistical adjustments were accordingly instituted. Following such statistical adjustment, age by itself did change gender's impact on LOS.

Another variable that should be discussed is rehabilitation status. Ireland, Kelly, and Cumming (2015) stated that "referral to hospital-based rehabilitation effectively doubles the total LOS," suggesting that anyone who is subject to rehabilitation after their acute hospital stay will have a longer LOS. This suggests that a patient's post-operative rehabilitation status should be taken into account when determining their LOS. It may be that patients

Table 4: The Collected General Variables.

		All patients	Males	Females
Length of Hospital Stay (Days)		5.3	4.7±3.7	5.7±3.1
Gender			140 (42%)	190 (57%)
Age		58.0	56.1 ±13	58.6 ±9.7
	>60 years old	48.8%	46.4%	50.5%
Race	Caucasians		76.4%	64.2%
	African American		20.7%	34.7%
Type of Insurance	Medicare		56.4%	55.8%
	Medicaid		5.7%	7.9%
	Private Insurance		26.4%	24.7%
	Uninsured		5.0%	4.7%
	Other		5.0%	6.8%
Number of Operated Levels	1		47.1%	42.1%
	2		27.1%	32.6%
	3		16.4%	15.8%
	>3		9.3%	9.5%
Body Mass Index (BMI in kg/m2)		31.1	30.3	31.6
Anti-Platelet use		26.4%	28.3%	25.0%
Drain insertion		64.3%	66.7%	62.6%
Cell Saver Use		72.9%	68.8%	75.8%
The Need for Blood Transfusion		10.5%	7.3%	12.8%
Preoperative Hemoglobin Level		13.4	14.3	12.7
Postoperative Hemoglobin Level		9.5	10.3	8.9
Vitamin D (ng/mL)		27.3	28.9	26.3
	Vitamin D < 20	29.1%	19.5%	35.5%

otherwise able to depart a tertiary care facility are shunted into a rehabilitation facility because of inadequate domestic support apparatus. Secondly, in some circumstances, discharge arrangements may have been expedited, preoperatively, so that in some cases those patients going to rehabilitation facilities will leave the hospital sooner than a cohort returning to a home environment.

Implications for Practice and/or Policy

A past history of anxiety disorders and developing postoperative psychiatric symptoms occurred more frequently in females than in males; issues which have been suggested to cause a prolonged hospital LOS (Stundner, et al., 2013; Zatzick, et al., 2000). Moreover, studies consistently assert that chronic

pain states are more prevalent in patients with anxiety disorders (Dersh, Polatin, Gatchel, 2000; Lachlan, McWilliams, Cox, 2003; Demyttenaere, Bruffaerts, Lee, 2007) and depressive disorders (Banks, Kerns, 1996; Dersh, Polatin, Gatchel, 2000; Von Korff, et al., 2005; Currie and Wang, 2004). Furthermore, women tend to have more severe pain scores, and perform more poorly on tests of cognitive function postoperatively than men (Heyer, et al., 2000). Also, it was suggested by Korovessis, Pepantis, Papazisis, and Iliopoulos (2010) that males show significantly better improvement in their lower back pain scores than their female counterparts following spine surgery. The psychological, pain, and cognitive burdens that females must face after surgery suggest that females are innately inclined to poorer postoperative outcomes and, thus, an elongated LOS.

In our study cohort females were afflicted with more comorbidities than were males possibly referable to the differing hormonal profile of females that could provide further insight as to why female's have a longer LOS than men. Studies consistently mentioned that estrogen modulates pain sensation via its α and β receptors that spread throughout the central and peripheral nervous systems (Alstergren, Ernberg, Kvarnström, Kopp, 1998; Nomura, et al., 2005; McEwen and Alves, 1999), including the dorsal root ganglia (Papka, et al., 2001), as well as throughout inflammatory cells like monocytes (Phiel, Henderson, Adelman, Elloso, Lett, 2005). The study performed by Craft et al. implicated that estrogen was a stimulant of nociceptive afferents in the peripheral nervous system via different mechanisms (Craft, 2007). Female's inclination to have a higher sensitivity to pain, and their increased tendency to psychiatric distress both could contribute to their elongated LOS.

Conclusion

Understanding the differences in gender for different operative interventions and paying special attention to gender dissimilarities might be useful to decrease postoperative stay and, thus, diminish healthcare expenditure.

We suggest additional inquiry into the impact of comorbidities and complications with particular reference as to why certain comorbidities and complications contribute to prolonging female LOS and not male.

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