

Safety of Immediate Posterior Trunk Soft-Tissue Reconstruction in Older Adults

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Background: Older patients, especially those older than 65 years, are accounting for an ever-increasing share of hospital costs, especially surgical procedures. Studies regarding the safety of surgery in these patients have been widespread in the past decade. Despite these efforts, there is a paucity of information regarding the safety of reconstruction following spinal surgery in older patients.

Methods: We conducted a retrospective cohort study of patients undergoing soft-tissue reconstruction of the posterior trunk after oncologic spine surgery. Demographic, medical, and surgical variables were measured. The primary outcome variable was the development of a medical or surgical complication postoperatively. Other secondary outcomes included development of a medical complication alone, specific surgical complications (seroma, hematoma, infection, wound dehiscence, and (cerebrospinal fluid leak), unplanned reoperation, and 60-day operative mortality.

Results: A priori power analysis suggested 205 cases would be needed. The study included 286 cases in 256 patients. The cohorts were similar in terms of demographic, surgical, and medical variables, though the older cohort had higher mean American Society of Anesthesiologists score (2.09 versus 1.65; $P < 0.0001$). We found no correlation between increasing age and increased rates of medical or surgical complications (35.9% for older patients versus 44.7% for younger patients; $P = 0.31$). However, mean American Society of Anesthesiologists score did correlate with complications (1.88 for patients with complications versus 1.69 for patients without; $P = 0.04$).

Conclusions: We demonstrated no increased risk for complications among older patients. Complex soft-tissue reconstruction of the posterior trunk is safe in elderly patients undergoing oncologic spinal surgery. (*Plast Reconstr Surg Glob Open* 2017;5:e1326; doi: 10.1097/GOX.0000000000001326; Published online 25 May 2017.)

INTRODUCTION

A major change facing medicine is the increasing proportion of elderly patients within the United States patient population. Patients 65 years and older accounted for 33% of hospital stays and 41% of hospital costs in 2010.¹ The U.S. Census estimates that this population will continue to expand, leading to elderly patients comprising upward of

20% of the American population as soon as 2030.² Elderly patients can be expected to comprise an increasing proportion of surgical cases performed each year as well.

In recent years, surgical outcomes researchers have been keenly interested in studying this segment of the population. Hundreds of studies have been published spanning all surgical fields, including general surgery, orthopedics, urology, gynecology, and neurosurgery.³⁻⁹ A common theme between studies is to investigate the correlation between age, morbidities, and outcomes. Depending on the nature of the procedure, findings vary significantly. Plastic and reconstructive surgeons have made extensive contributions to this body of literature, covering areas such as breast, craniofacial, hand, microsurgery, burn, and aesthetic surgery.¹⁰⁻¹⁵ Outcomes of elderly patients undergoing oncologic reconstruction have been studied for certain regions, primarily head and neck and breast cancers.^{16,17} However, there is a paucity of published

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This study was conducted with approval of our institution's institutional review board.

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data regarding the outcomes of aged patients undergoing reconstruction following oncological spine surgery.

We sought to investigate whether in cases of trunk reconstruction after spine surgery if increased age of the patient is associated with increased postoperative complications. We hypothesized that with careful preoperative evaluation and medical optimization, elderly patients would experience a similar rate of postoperative complications as a cohort of younger patients. The specific aims of this study were 3-fold: (1) to analyze 2 cohorts of neurosurgical spine patients undergoing reconstructive surgery divided based on age, (2) to estimate the prevalence of postoperative complications in these 2 groups, and (3) to compare safety outcomes between the cohorts.

METHODS

Study Design and Subjects

This study was a retrospective cohort study of patients derived from a prospectively collected database. The study was approved by the Johns Hopkins Institutional Review Board. Patients included were those seen at our institution and treated within the Departments of Neurosurgery and Plastic and Reconstructive Surgery over a 12-year period (2002–2014). Inclusion criteria were the following: (1) age 18–100 years at the time of surgery, (2) minimum of 6 months of follow-up after their initial operation, (3) complete electronic medical record, and (4) tumor resection performed by a neurosurgeon with soft-tissue reconstruction done by a plastic and reconstructive surgeon.

Chronological age was measured from birth to the date of the index neurosurgical spinal tumor resection.

Study Variables

The primary outcome variable in this study was the dichotomous development of a postoperative complication, either surgical (i.e., wound complication) or medical (i.e., pneumonia, cardiac arrest). Secondary variables were development of a medical complication, the type of wound complication [seroma, hematoma, infection, wound dehiscence, and cerebrospinal fluid (CSF) leak], major complication requiring unplanned reoperation, and 60-day operative mortality.

Other variables collected in this study included demographic variables (gender), medical comorbidities, smoking status, chronic steroid/immunosuppression use, and surgical history (previous spine radiation, previous spine surgery, and spinal hardware).

Data Collection, Management, and Analyses

Subjects were input into the database in a consecutive manner. A priori logistic regression power analysis was carried out using PASS 11 (NCSS, Kaysville, Utah) with the following parameters: α of 0.05, β of 0.2, estimated percentage of elderly patients 25%, baseline incidence of any complication for nonelderly patients 30%, and a detected odds ratio for elderly patients of 2.5. Descriptive statistics were computed for the study population. Bivariate analysis (logistic regression, 2-tailed *t* test, or chi-square test, as

appropriate) was used to determine significance of associations between the predictor variable and the outcome variables. A *P* value of 0.05 was established as the threshold for statistical significance. Multivariate logistic regression was used to control for possible covariates with a preset threshold of $P < 0.1$ for entry into the multivariate model. Goodness-of-fit tests were used to validate the overall models. Statistical computations were carried out using Stata/SE version 12.0 (StataCorp Inc., College Station, Tex.).

RESULTS

A Priori Power Analysis

Our power analysis suggested that a minimum of 205 cases would be necessary to detect an effect of the desired size with 80% power given our model parameters.

Demographics

A total of 286 cases in 256 patients were included in the study. The ages ranged from 18 to 93 years old. The distribution of females, smokers, immunosuppressed/steroid users, and those with a history of spinal radiation or surgery was similar between cohorts (Table 1). The older cohort had higher rates of diabetes mellitus and cardiovascular morbidity, 28.2% versus 12.1% ($P = 0.0004$) with diabetes and 59.0% versus 26.4% ($P < 0.0001$) with cardiovascular disease. Additionally, younger patients demonstrated a lower mean American Society of Anesthesiologists (ASA) Physical Status score of 1.65 compared with the mean ASA of 2.09 in the older cohort ($P < 0.0001$). Paraspinal flaps were the most commonly used flap in both cohorts (Table 2).

Table 1. Patient Demographics

Variables	Statistics		<i>P</i>
	≥ 65 Y	< 65 Y	
Sample size	78	208	NA
Female sex (%)	41 (52.6)	100 (48.1)	0.25
Average age (y)	72.2 ± 6.6	46.5 ± 12.3	< 0.0001
Current smoker (%)	6 (7.7)	30 (14.4)	0.084
Diabetes mellitus (%)	22 (28.2)	25 (12.1)	0.0004
Cardiovascular morbidity (%)	46 (59.0)	55 (26.4)	< 0.0001
Chronic immunosuppression/ steroid use (%)	9 (11.5)	14 (6.7)	0.11
Mean ASA score	2.09	1.65	< 0.0001
Spinal instrumentation (%)	63 (80.8)	151 (72.6)	0.08
Preoperative spinal radiation (%)	27 (34.6)	69 (33.1)	0.41
Previous spine surgery (%)	50 (64.1)	113 (54.3)	0.07

All *P* values calculated using 2-sided Student's *t* test. NA, not applicable.

Table 2. Flap Selection

Reconstructive Technique	≥ 65 Y	< 65 Y
Paraspinal flap (%)	35 (44.9)	89 (42.8)
Direct closure (%)	6 (7.7)	15 (7.2)
Gluteus flap (%)	9 (11.5)	28 (13.5)
Rectus abdominis (%)	1 (1.3)	7 (3.4)
Trapezius (%)	12 (15.4)	14 (6.7)
Two or more flaps* (%)	13 (16.7)	50 (24.0)
Other† (%)	2 (2.6)	5 (2.4)

*Two or more of the flaps listed above.

†Other flaps included latissimus dorsi, rhomboid, platysma, and fibula.

Age and Overall Postoperative Complications

We found no associations between overall complication rates and most demographic factors sampled except mean ASA score (Table 3). There were 28 complications in the cohort of patients who were older than 65 years, which produced a complication rate of 35.9%; there were 93 complications in the younger cohort, producing a complication rate of 44.7% (Table 4). This was not significant ($P = 0.31$). Mean ASA score correlated with complications, such that patients with a complication had a mean ASA score of 1.88 versus a mean ASA score of 1.69 for patients without a complication ($P = 0.04$).

Age and Specific Postoperative Complications

The medical complications observed are presented in Table 5. The secondary outcome variables considered in-

cluded development of a medical complication, the type of wound complication (seroma, hematoma, infection, wound dehiscence, and CSF leak), complication requiring reoperation, and 60-day operative mortality (Table 6). A significant correlation was found between decreased age and development of wound dehiscence (19.2% versus 9.0%; $P = 0.016$). There was no correlation between increasing age and development of a medical complication (14.1% for older patients versus 13.0% for young patients; $P = 0.804$).

DISCUSSION

This study was conducted to determine the safety of performing posterior trunk reconstruction in patients older than 65 years who had undergone spinal tumor resection. We hypothesized that the cohort of older patients would experience complication rates similar to that of younger patients.

Our results tend to support the hypothesis that increasing age does not increase the odds of developing a postoperative complication. Younger patients experienced postoperative complications in 44.7% of cases and older patients experienced complications in 35.9% of cases. The only secondary variable that showed a significant difference was the development of wound dehiscence; 19.2% of younger patients were affected compared with 9.0% of older patients ($P = 0.016$). The a priori power analysis based on reasonable values for type I error, type II error, and effect size suggests that our study is sufficiently powered to detect these differences. Based on our data, posterior trunk reconstruction is safe in elderly patients.

With an ever-advancing life expectancy, the pool of surgical patients will continue to skew older. Earlier studies suggest that surgical risk increases substantially beyond the age of 60 years: for each year beyond 60 years, there is up to a 3 times increased risk of death from surgery.^{18,19} From a physiological standpoint, this is logical as reserve capacity decreases for nearly all organs with age and stress becomes increasingly detrimental.²⁰

As recently as 2015, some authors have argued that certain complex soft-tissue reconstructions may be too demanding for elderly patients due to high morbidity.²¹⁻²³ However, advances in anesthesia methods along with surgical techniques have allowed even complicated reconstructive methods to proceed with success.²⁴⁻²⁶

Table 3. Associations Between Postoperative Complications and Predictors

Variables	Statistics		P
	Complication	No Complication	
Sample size (%)	121	165	NA
Female sex (%)	62 (51.2)	79 (47.9)	0.58
Current smoker (%)	15 (12.4)	21 (12.7)	0.90
Diabetes mellitus (%)	19 (15.7)	28 (17.0)	0.77
Cardiovascular morbidity (%)	49 (40.5)	52 (31.5)	0.12
Chronic immunosuppression/steroid use (%)	9 (7.4)	14 (8.5)	0.75
Mean ASA score	1.88	1.69	0.04
Spinal instrumentation (%)	93 (76.9)	121 (73.3)	0.50
Preoperative spinal radiation (%)	46 (38.0)	50 (30.3)	0.18
Previous spine surgery (%)	68 (56.2)	95 (57.6)	0.81

P values calculated using 2-sided Student's *t* test, except for mean ASA score, which was calculated using a chi-square test. NA, not applicable.

Table 4. Association Between Postoperative Complications and Age

Variables	Statistics			P
	Complication (%)	No Complication (%)	Total	
≥ 65 y	28 (35.9)	50 (64.1)	78	0.31
< 65 y	93 (44.7)	115 (55.3)	208	
Total	121	165	286	

P value calculated using chi-square test.

Table 5. Medical Complications Observed during the Inpatient Postoperative Period

Medical Complication	No. Instances (%)*
Deep venous thrombosis	5 (1.7)
Pulmonary embolism	4 (1.4)
Sepsis	11 (3.8)
Urinary tract infection	6 (2.1)
Pneumonia	6 (2.1)
Meningitis	1 (0.3)
Bowel perforation	1 (0.3)
Small bowel obstruction	2 (0.7)
Acute renal failure	4 (1.4)
Cardiac arrest	2 (0.7)

*% Of entire study sample.

Some patients developed more than 1 medical complication.

Table 6. Associations Between Secondary Outcome Variables and Age

Variables	Statistics		P
	≥ 65 y	< 65 y	
Medical complication (%)	11 (14.1)	27 (13.0)	0.804
Infection (%)	13 (16.7)	55 (26.4)	0.063
Seroma (%)	5 (6.4)	28 (13.5)	0.055
CSF leak (%)	2 (2.6)	12 (5.7)	0.187
Hematoma (%)	0	2 (1.0)	NA
Wound dehiscence (%)	7 (9.0)	40 (19.2)	0.016
Complication requiring reoperation (%)	11 (14.1)	53 (25.5)	0.101
60-Day operative mortality (%)	2 (2.6)	6 (2.9)	0.898

P values calculated using 2-sided Student's *t* test. NA, not applicable.

Our results did not find a correlation between increased age and increased postoperative complications. However, we did demonstrate that higher ASA score is correlated with an increased prevalence of postoperative complications ($P = 0.04$). The lack of correlation between age and complications,^{27,28} as well as the positive correlation between ASA and complications,^{29,30} are in concordance with reports for other areas of reconstruction. An elevated ASA score, though, is based on a preoperative assessment of poorer health and an increased ASA score should be expected to correlate with worse outcomes. That these findings remain consistent with other reports is encouraging, given that spine tumor resection with reconstruction is a much more physiologically challenging procedure than, for example, breast reconstruction after mastectomy.

Interestingly, we identified a trend toward increased wound complications in the younger cohort. Although infection and seroma risk were not statistically significantly different, the rate of wound dehiscence between the cohorts differed significantly. Similar reconstructive algorithms were used for both older and younger patients, as follows: first, direct closure is considered provided there is no excessive tension, poor soft-tissue quality or exposed hardware. If this is not an option, locoregional muscle flap coverage is performed, with paraspinous muscle flaps generally being the first choice. When this is not an option or additional coverage is needed, additional flaps are used based on the defect region, such as trapezius (cervical), latissimus dorsi (thoracic), or gluteus (lumbosacral). Despite this largely uniform approach, a possible explanation for the observed increase in dehiscence for younger patients might be the relatively higher number of lumbosacral reconstructions, many of which require 2 flaps (gluteus and paraspinal). It is possible that the use of 2 flaps predisposed to wound dehiscence. Additionally, it is very likely that aggressive postoperative rehabilitation strongly contributed to this trend. Our institution favors early ambulation and physical therapy, especially for younger patients. Although rates of wound dehiscence appear to increase as a result of this physical therapy regimen, the overall functional benefits outweigh the relatively minimal drawbacks of this local complication. Further study is needed to assess the efficacy and safety of early postoperative rehabilitation in older patients.

Special considerations should be made when reconstructing the posterior trunk in the elderly. The spine and its associated muscles are absolutely essential for a functional gait. Healthy older adults are already known to have diminished balance and stability as a result of their age,³¹ for which they compensate with decreased cadence and stride length.³² From the plastic surgeon's standpoint, reconstruction of the paraspinal soft tissues is essential to preserving any remaining truncal stability. Consequently, particular consideration should be made to limiting muscle sacrifice to the minimum amount necessary to achieve healthy vascularized coverage. Establishing the safety of trunk reconstruction in these patients supports the role of plastic surgery in the multidisciplinary care of these complex procedures.

The decision to divide patients into cohorts with a cutoff of 65 years was made based on Medicare policy and precedent set by previous authors. Medicare automatically comes into effect when a patient reaches 65 years old, making this a convenient cutoff for our analysis of elderly patients. Furthermore, this age cutoff has been used in numerous other similar studies of surgical outcomes.^{33–36}

Our report is limited by 3 main factors. First, we examined only operative patients undergoing reconstruction. Accordingly, we cannot rule out biases regarding the delegation of patients to operative versus nonoperative treatment (either by not undergoing spine surgery or forgoing reconstruction). It certainly seems likely that there is a population of comorbid elderly patients who are not considered surgical candidates. However, we did not see demographic differences between younger and older patients to suggest that only the healthiest elderly patients are offered surgery. Second, we acknowledge that the retrospective nature of our data may lead to uncontrollable bias regarding how a given reconstructive method was chosen. However, we did see a comparable selection of flap choices between the younger and older cohorts. Finally, we could not assess other factors such as length of stay or effectiveness metrics. Our study presents the first major report of safety data for older patients undergoing spinal reconstructions. Future studies will be needed to answer questions surrounding the financial and functional impact of reconstruction in elderly patients.

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