Effects of Psoas Muscle Thickness on Outcomes of Lumbar Fusion Surgery

Terence Verla[1], Owoicho Adogwa[2], Aladine Elsamadicy[2], Jessica R. Moreno[3], Harrison Farber[2], Joseph Cheng[4], Carlos A. Bagley[3]

BACKGROUND: **Lumbar arthrodesis is a surgical option for treatment of lumbar pathologies. Stability of the spinal construct partly depends on load-bearing support from back muscles. Despite the role of the psoas muscle in upright spinal stabilization, data describing its clinical significance are scarce. We evaluated the effects of the psoas muscle thickness on outcomes after lumbar fusion surgery.**

METHODS: **A retrospective review was performed of hospital records (2007–2013) of adult patients undergoing lumbar fusion surgery. Patients ≥18 years old who had undergone ≥1 level of lumbar fusion with available preoperative magnetic resonance imaging scans and at least 1 year of follow-up were included. Axial psoas muscle thickness was measured at each lumbar intervertebral space. Psoas muscle thickness at each vertebral level was compared between patients with and without the occurrence of specific clinical outcomes.**

RESULTS: **There were 257 patients included. The average age was 58.15 years; about 45% of patients were men. Most of the patients underwent a transforaminal interbody fusion surgery (58.4%). The average psoas muscle thickness ranged from 11.49 mm at L1-2 to 36.51 mm at L4-5. Patients with postoperative hip flexor weakness and increased time to ambulation had significantly smaller psoas muscle thickness. Also, patients with >50% improvement in visual analog scale pain score had significantly greater psoas muscle thickness.**

CONCLUSIONS: **This study shows that the psoas muscle can be beneficial in overall postoperative rehabilitation with early ambulation and greater improvement in functional outcomes. Given the role of the psoas muscle in spinal stabilization, the effect of psoas muscle thickness on postoperative functional outcomes warrants further investigation.**

INTRODUCTION

Lumbar arthrodesis has been widely adopted as a surgical option for the treatment of lumbar pathologies, including spondylolisthesis, degenerative disc disease, and stenosis.[1,2] Several factors influence surgical outcomes in patients undergoing fusion surgery. Obesity, age, extent of fusion, and patient comorbidities are known factors that increase the risk of surgical complications. Adjacent segment degeneration (ASD) has been shown to occur in 2%–7% of patients undergoing lumbar fusion. Risk factors for ASD include length of fusion, prior surgery, patient age, and obesity.[3-6] However, these negative outcomes can potentially be mitigated by increased dynamic stability of the spine using the body's own natural postural mechanism. The psoas muscle and other intrinsic back muscles emerge as critical players in this crucial role of spinal stability.

Numerous studies have shown that atrophy of psoas and deep back musculature is one of the causes of low back pain, creating a restrictive milieu for spinal movement.[7-11] Furthermore, the psoas muscle plays a valuable role in stabilization of the lumbar spine in the upright position,[12-14] with several studies reporting pain relief and reduction in functional disability secondary to exercises that increase psoas strength and thickness, contributing to the enhanced stability of the spine.[15-17] Given the occurrence of

Key words
- Complications
- Functional outcomes
- Lumbar spine fusion
- Psoas muscle

Abbreviations and Acronyms
ASD: Adjacent segment degeneration
BMI: Body mass index
DVT: Deep vein thrombosis
MRI: Magnetic resonance imaging
PE: Pulmonary embolism

From the [1]Department of Neurosurgery, Baylor College of Medicine, Houston, Texas; [2]Division of Neurosurgery, Duke University Medical Center, Durham, North Carolina; [3]Department of Neurosurgery, University of Texas Southwestern, Dallas, Texas; and [4]Department of Neurosurgery, Vanderbilt University Medical Center, Nashville, Tennessee, USA

To whom correspondence should be addressed: Terence Verla, M.D., M.P.H. [E-mail: Terence.verla@bcm.edu]

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perioperative and postoperative complications after spinal fusion surgeries, we hypothesize that patients with larger caliber psoas muscle have an added advantage of enhanced static and dynamic stability of the spine and can thus have fewer surgical complications with greater improvement in postoperative functional outcomes. The primary aim of this study was to evaluate the effect of the psoas muscle thickness on the incidence of surgical complications and functional improvement after lumbar spinal fusion.

MATERIALS AND METHODS

Patient Selection

A retrospective review of Duke University Hospital records from January 2007 to January 2013 was performed of adult patients undergoing a lumbar spinal fusion procedure. Patients >18 years old who had undergone ≥1 levels of lumbar fusion with available preoperative magnetic resonance imaging (MRI) scans and at least 1 year of follow-up were included. The exclusion criteria included 1) history of previous infections at the surgical site, 2) severe coexistent pathology that could confound the assessment of operative outcome, 3) history of immunosuppression or chronic systemic infection, and 4) pregnancy. Patient demographics, clinical presentation, comorbidities, radiologic studies, and all treatment variables were reviewed for each case.

Psoas Muscle Measurement

MRI scans were obtained on all patients during their preoperative evaluation. Only patients with MRI scans performed within 90 days of surgery were considered. T1-weighted images were used to identify the borders of the psoas muscle among the retroperitoneal fat. Axial psoas muscle thickness was measured at each lumbar intervertebral space (L1-2, L2-3, L3-4, L4-5, L5-S1) using picture archiving and communication system image analysis software (Figure 1). To reduce variance in the measured thickness, 2 investigators (T.V. and A.E.) obtained measurements, and the results were averaged.

Outcome Variables

Preoperative and intraoperative data for each patient were collected with use of patient charts and computerized medical records. Baseline characteristics were documented for each patient, including age; sex; body mass index (BMI); tobacco use; and history of chronic obstructive pulmonary disease, coronary artery disease, and hypertension. Pertinent operative details were also collected, including number of levels instrumented, estimated blood loss, and duration of surgery.

We also assessed the rate of postoperative wound infection, durotomy, cerebrospinal fluid leak, nerve root injury, and other negative outcomes (e.g., deep vein thrombosis (DVT)/pulmonary embolism (PE), urinary tract infection, psoas hematoma). Specific complications of interest in the study included nerve root injury, psoas hematoma, anterior thigh numbness, hip flexor weakness, wound infection, pseudarthrosis, hardware failure, and ASD. Other outcomes of interest included operating room time, hospital length of stay, time to ambulation, and changes in functional outcome scores (visual analog scale and Oswestry Disability Index). The thickness of the psoas muscle at each intervertebral level was compared between patients with the occurrence of the variables of interest and patients without the variables of interest, using χ^2 test for categorical variables and Student t test for continuous variables.

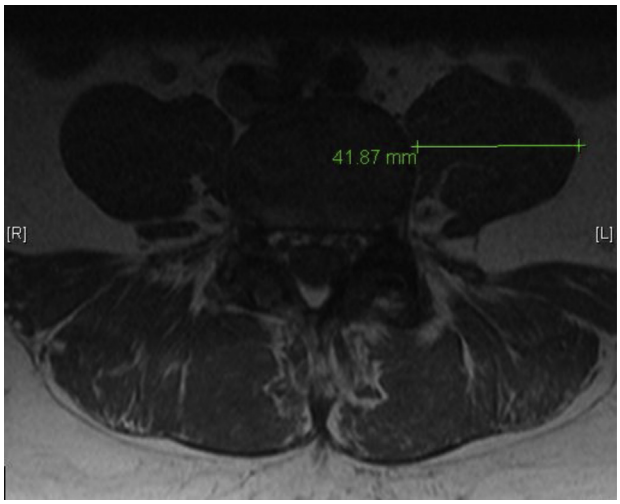

Figure 1. T1-weighted magnetic resonance imaging showing measurement of the axial thickness of the psoas muscle at each lumbar level.

Statistical Analysis

The primary aim of this study was to determine if the thickness of the psoas muscle has an effect on postoperative outcomes. Parametric data were expressed as mean ± SD and were compared using Student t test. Nonparametric data were expressed as the median (interquartile range) and were compared using the Mann-Whitney U test. Nominal data were compared with χ^2 test. $P < 0.05$ was considered statistically significant.

RESULTS

This Retrospective Study Included 257 Patients

The average age ± SD was 58.15 years ± 14.96; approximately 45% of patients were men. The overall mean ± SD BMI was 27.64 kg/m^2 ± 5.33. Most of the patients underwent transforaminal interbody fusion surgery (58.4%), and the remaining patients underwent posterior fusion (17.1%) and transpsoas or lateral lumbar interbody fusion (24.5%). The average duration of follow-up was 15.7 months. The most frequent preoperative diagnosis was spondylosis (84.0%), and low back pain was the most common presenting symptom (92.2%). Demographic characteristics of the patients are shown in Table 1. Fusion was most frequently performed at the L4-5 level, followed by L3-4. The average psoas muscle thickness ranged from 11.49 mm at L1-2 to 36.51 mm at L4-5. Table 2 shows the intervertebral levels fused and the corresponding psoas muscle thickness. The 3 most common complications were decreased strength in hip flexion (11.4%), followed by urinary tract infection (6.87%)