ScientificScholar®
Knowledge is power
Publisher of Scientific Journals

www.surgicalneurologyint.com

# Surgical Neurology International

**Editor-in-Chief:** Nancy E. Epstein, MD, Clinical Professor of Neurological Surgery, School of Medicine, State U. of NY at Stony Brook.

*SNI: Spine*

**Editor**
Nancy E. Epstein, MD
Clinical Professor of Neurological Surgery, School of Medicine, State U. of NY at Stony Brook

SNI
Open Access

*Original Article*

# Variability in wound closure technique in midline posterior lumbar fusion surgery. International survey and standardized closure technique proposal

Oscar Josue Montes Aguilar[1], Karmen Karina Alaniz Sida[2], Leonardo Álvarez Betancourt[3], Manuel Dufoo Olvera[1], Guillermo Ivan Ladewig Bernaldez[1], Ramón López López[3], Edith Oropeza Oropeza[1], Héctor Alonso Tirado Ornelas[3]

[1]Department of Spine surgery, Spine Clinic "Dr. Manuel Dufoo Olvera," Departments of [2]Neuroanesthesiology, [3]Neurosurgery, Specialty Hospital- National Medical Center "La Raza", Mexico City, Mexico.

E-mail: *Oscar Josue Montes Aguilar - oscar_16031@hotmail.com; Karmen Karina Alaniz Sida - karialanizs@gmail.com; Leonardo Álvarez Betancourt - leoalvarezb1@hotmail.com; Manuel Dufoo Olvera - mdufoo27@yahoo.com; Guillermo Ivan Ladewig Bernaldez - dr.ladewig@gmail.com; Ramón López López - dr_ramonzl@hotmail.com; Edith Oropeza Oropeza - dra.edith.oropeza@gmail.com; Héctor Alonso Tirado Ornelas - hector.alonso.7@hotmail.com

***Corresponding author:**
Oscar Josue Montes Aguilar, Department of Spine Surgery, Spine Clinic "Dr. Manuel Dufoo Olvera," México City, Mexico.

oscar_16031@hotmail.com

Received : 20 September 2022
Accepted : 27 October 2022
Published : 18 November 2022

**DOI**
10.25259/SNI_872_2022

**Quick Response Code:**

## ABSTRACT

**Background:** Surgical wound complications represent an important risk factor, particularly in multilevel lumbar fusions. However, the literature regarding optimal wound closure techniques for these procedures is limited.

**Methods:** We performed an online survey of 61 spinal surgeons from 11 countries, involving 25 different hospitals. The study included 26 neurosurgeons, 21 orthopedists, and 14 residents (Neurosurgery – 6 and orthopedics 8). The survey contained 17 questions on demographic information, closure techniques, and the use of drainage in posterior lumbar fusion surgery. We then developed a "consensus technique."

**Results:** The proposed standardized closure techniques included: (1) using subfascial gravity drainage (i.e., without suction) with drain removal for <50 ml/day or a maximum duration of 48 h, (2) paraspinal muscle, fascia, and supraspinous ligament closure using interrupted-X stitches 0 or 1 Vicryl or other longer-lasting resorbable suture (i.e., polydioxanone suture), (3) closure of subcutaneous tissue with interrupted inverted Vicryl 2-0 sutures in two planes for subcutaneous tissue greater >25 mm in depth, and (4) skin closure with simple interrupted nylon 3-0 sutures.

**Conclusion:** There is great variability between closure techniques utilized for multilevel posterior lumbar fusion surgery. Here, we have described various standardized/evidence-based proven techniques for the closure of these wounds.

**Keywords:** Midline posterior lumbar fusion, Spine surgery, Standardized closure, Wound closure

## INTRODUCTION

Surgical wound complications (incidence: 0.2–20%) for patients undergoing multilevel lumbar fusion surgery represent major risk factors that increase morbidity, mortality, and hospital costs.[5,13,14] Notably, there is scant consensus regarding the optimal lumbar wound closure techniques. Here, we offer a standardized and potentially optimal summary of the key wound closure techniques that should be utilized to close multilevel lumbar fusions.

## MATERIALS AND METHODS

We conducted an online survey of 61 participants: 26 neurosurgeons (+6 residents), 21 orthopedists (+8 residents) from 11 countries, to 25 different hospitals [Table 1]. Our survey (i.e., in Spanish and English) contained 7 questions regarding the use of various standardized closure techniques. It included how to close multilevel lumbar fusions, what sutures to use, when drains should be placed, and for how long [Table 2]. Three orthopedists and three neurosurgeons from two hospitals in Mexico City then developed a "consensus technique" based on an analysis of the survey data.

## RESULTS

Although 50.8% (31) of surgeons reported using a standardized closure method, they utilized different techniques for each of the planes of closure. In all, we encountered 61 different closure combinations for the 61 participants [Table 2].

**Table 1:** Demographics of participants in the survey of closure technique in spine surgery for posterior lumbar fusion.

| Variable | % (*n*) |
|---|---|
| Age | 33 (25–77) |
| Medium surgeries/year | 25 |
| Country of origin | |
| Mexico | 68.9 (42) |
| Chile | 13.1 (8) |
| Argentina | 5 (3) |
| Brazil | 1.6 (1) |
| Colombia | 1.6 (1) |
| Ecuador | 1.6 (1) |
| India | 1.6 (1) |
| Peru | 1.6 (1) |
| Puerto Rico | 1.6 (1) |
| United States of America | 1.6 (1) |
| Venezuela | 1.6 (1) |
| Speciality | |
| Neurosurgeon | 42.6 (26) |
| Orthopedist | 34.4 (21) |
| Orthopedics resident | 13.1 (8) |
| Neurosurgery resident | 9.8 (6) |
| Complementary training in spine surgery | |
| Yes | 26 |
| No | 26 |
| In training | 9 |
| Training hospital | |
| Mexico City Spine Clinic | 16.3 (10) |
| Clinic Hospital of Chile University | 11.4 (7) |
| General Regional Hospital 2. | 9.8 (6) |
| National Medical Center "La Raza" | 9.8 (6) |
| National Institute of Neurology & Neurosurgery | 6.6 (4) |
| Rehabilitation National Institute | 6.6 (4) |
| Orthopedics and Traumatology Hospital "Lomas Verdes" | 4.9 (3) |
| Social Security Institute of the Mexico State and Municipalities "Ecatepec" | 3.2 (2) |
| Others. | 31.2 (19) |

## DISCUSSION

We analyzed the variability in the midline posterior closure techniques utilized by 26 neurosurgeons, 21 orthopedists,

**Table 2:** Results of the survey of closure technique in spine surgery for posterior lumbar fusion: variability in closure techniques in different anatomic planes.

| # | TECHNIQUES | % (N) |
|---|---|---|
| | WOUND DRAINS | |
| 1 | Subfascial with suction | 36.1 (22) |
| 2 | No Drain | 27.9 (17) |
| 3 | Subfascial without suction | 16.4 (10) |
| 4 | Subcutaneous with suction | 16.4 (10) |
| 5 | Subcutaneous without suction | 3.3 (2) |
| | MUSCLE | |
| 1 | No sutures | 49.2 (30) |
| 2 | Vicryl- Single interrupted | 26.2 (16) |
| 3 | Vicryl-interrupted X. | 16.4 (10) |
| 4 | Vicryl-inverted | 8.2 (5) |
| 5 | Monocryl-simple | 4.9 (3) |
| | FASCIA | |
| 1 | Vicryl-interrupted X. | 40.9 (25) |
| 2 | Monocryl-Single interrupted | 21.3 (13) |
| 3 | Vicryl- Continuous | 16.3 (10) |
| 4 | Vicryl-Locking continuous | 9.8 (6) |
| 5 | Monocryl-interrupted X. | 4.9 (3) |
| 6 | Vicryl-Other technique | 3.3 (2) |
| 7 | Monocryl- Continuous | 3.3 (2) |
| | SUPRASPINOUS LIGAMENT | |
| 1 | Include supraspinous ligament | 50.8 (31) |
| 2 | Supraspinous ligament not included | 49.2 (30) |
| | SUBCUTANEOUS TISSUE | |
| 1 | Vicryl-Inverted-2 planes | 27.9 (17) |
| 2 | Vicryl-Single interrupted-1 plane | 21.3 (13) |
| 3 | Vicryl- Single-2 planes | 18.0 (11) |
| 4 | Vicryl-Inverted-1 plane | 13.1 (8) |
| 5 | Monocryl-Inverted-1 plane | 6.5 (4) |
| 6 | Monocryl-continuous-1 plane | 4.9 (3) |
| 7 | Monocryl-Inverted-2 planes | 3.3 (2) |
| 8 | Vicryl-Continuous-2 planes | 3.3 (2) |
| 9 | Monocryl-continuous-2 planes | 1.6 (1) |
| | SKIN | |
| 1 | Nylon-Single | 37.7 (23) |
| 2 | Nylon-Sarnoff | 18.0 (11) |
| 3 | Staple | 18.0 (11) |
| 4 | Nylon-Continuous | 14.7 (9) |
| 5 | Prolene-Single | 3.3 (2) |
| 6 | Prolene-intracutaneous | 1.6 (1) |
| 7 | Nylon-locking continuous | 1.6 (1) |
| 8 | Prolene-Locking continuous | 1.6 (1) |
| 9 | Monocryl-intracutaneous | 1.6 (1) |
| 10 | Nylon-intracutaneous | 1.6 (1) |

**Table 3:** Review of the literature on closure techniques in different anatomic planes.

| Author (year) | Study group | Results |
|---|---|---|
| USE OF DRAIN | | |
| Buser, *et al*. (2022) | Risk postop SSI in 671 patients with drains. | Drains do not increase infection rate, irrespective of levels or surgical duration.[1] |
| Shi, *et al*. (2021) | Drain removal criteria 743 patients - PLF - output >50 ml/day or postop day 2. | Benefits of wound drainage protocol <postop drain output, < EBL, < LOS hospital, earlier ambulation.[10] |
| Fang, *et al*. (2016) | Efficacy subfascial drain with CSF leak (Poiseuille's law) | Drain decreases subfascial space pressure-helps wound healing.[2] |
| Mirzai, *et al*. (2006) | 50 patients with or without insertion of a drain in epidural space. | Drain decreases incidence/size of hematoma 1st postop day.[8] |
| MUSCLE, FASCIA, AND SUPRASPINOUS LIGAMENT | | |
| Haupt, *et al*. (2022) | Biomechanical cadaveric study. | Suturing fascia to the spinal processes – no improved passive stability but reduces dead space for seroma and faster postoperative rehab.[3] |
| Klinger, *et al* (2019) | Technical report. | Reapproximation of lumbar multifidus to restore paraspinal anatomical integrity, may lead to improved outcomes, < postop pain, and > patient satisfaction.[4] |
| Suter, *et al*. (2019) | Leakage pressure of different suturing techniques for each layer in a sheep cadaveric model. | X stitches suturing (median=180 mbar) resulted in the most watertight closure for fascia closure.[12] |
| Yilmaz, *et al*. (2018) | Technical note. | 0 Vicryl suture to tightly reapproximate the fascial layer using a simple interrupted technique.[14] |
| Müller, *et al*. (2016) | Comparative study of six different suture materials in orthopedic surgery. | Vicryl was the strongest fiber on day 0 (195 N); Between days 14 and 28, polydioxanone suture II (171 N) and Maxon (182 N) sustained the highest loads.[7] |
| SUBCUTANEOUS TISSUE | | |
| Yilmaz, *et al*. (2018) | Technical note. | Inverted stitches of Vicryl 2-0.[14] |
| Mehta, *et al*. (2012) | A retrospective cohort of 298 adult patients who underwent PLF. | In obese patients, the distribution of BM (skin to lamina distance and thickness of the subcutaneous fat=30.2 mm) is more predictive of SSI than absolute BM index.[6] |
| SKIN | | |
| Shani, *et al*. (2020) | Incidence of SSI after the closure of the skin incision in open PLF with metal staples versus nylon sutures in 270 patients. | Closure of the skin incision with nylon sutures after open PLF carried a lower risk of postoperative SSI compared with metal staples (4.2 vs. 11.8%).[9] |
| Suter, *et al*. (2019) | Leakage pressure of different suturing techniques for each layer in a sheep cadaveric model. | No statically significant difference for skin hermetic closure between different suture techniques and PLF.[12] |
| Yilmaz, *et al*. (2018) | Systematic review | There is lack of evidence for an optimal wound closure technique in posterior spine surgery.[13] |

SSI: Surgical site infection, PLF: Posterior lumbar fusion, Postop: postoperative, EBL: Estimated blood loss, LOS: Length of stay, BM: Body mass

**Table 4:** Standardized closure technique: Summary.

| S. No. | Anatomic plane | Surgical technique | Comments |
|---|---|---|---|
| 1. | Drainage | Subfascial drain without suction (gravity drainage). Remove when volume <50 ml/day or a maximum of 48 h. | If larger volumes of drainage persist, look for a CSF leak. |
| 2. | Paraspinal muscles and fascia | Closed in two layers using interrupted-X stitches 0 or 1-0 Vicryl. Included supraspinous ligament-spinal processes to reduce dead space. | When available; Use polydioxanone suture II. (stronger and longer lasting tensile strength) |
| 3. | Subcutaneous tissue | Inverted Vicryl 2-0 in 2 planes (layers) for tissues >25 mm in depth. | When subcutaneous tissue depth <25 mm, closed with inverted stitches of Vicryl 2-0 in a single layer. |
| 4. | Skin | Simple stitches of nylon 3-0. | May use running 2 or 3-0 Monocryl. |

and 14 residents to perform multilevel lumbar spine fusion surgery. Different studies have individually evaluated closure techniques in multilevel lumbar fusion surgery [Table 3].

Our standardized technique first included utilizing a subfascial drain without suction (i.e., gravity drainage) with drain removal either when the volume was < 50 ml/day or

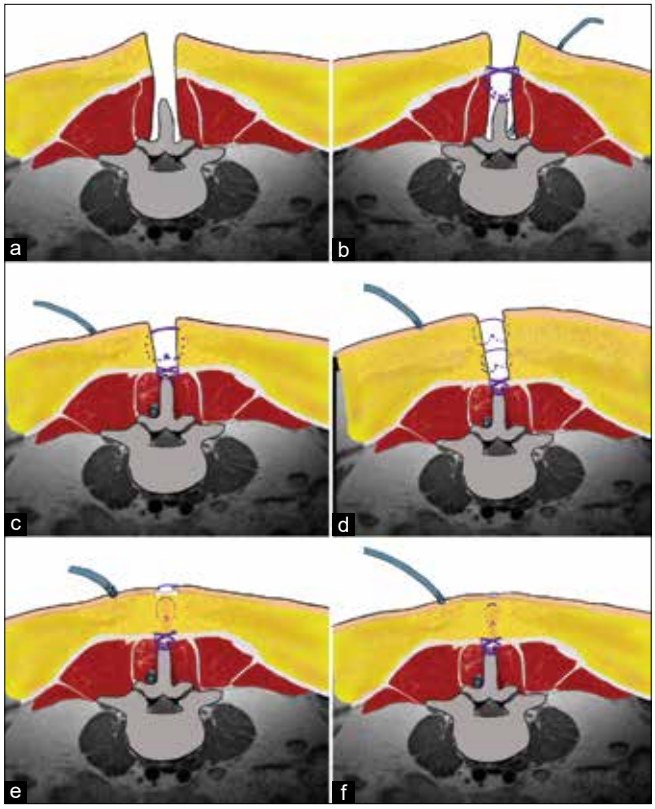


**Figure 1:** (a) Midline posterior lumbar approach. (b) Using subfascial gravity drainage (i.e., without suction) with drain removal for <50 ml/day or a maximum duration of 48 h; paraspinal muscle and fascia closure with an interrupted-X technique of Vicryl 1 or other longer-lasting resorbable suture and include the supraspinous ligament. (c) Closure of subcutaneous tissue with interrupted inverted stitches of Vicryl 2-0 in 1 single plane when depth <25 mm. (d) Two planes for subcutaneous tissue greater > than 25 mm in depth. (e) Skin closure with simple interrupted nylon 3-0 sutures. (f) Standardized closure.

when the drain has been in place a maximum of 48 h. (note: if larger volumes of drainage persist look for a cerebrospinal fluid leak).[1,2,8,10] Second, the paraspinal muscles, fascia, and supraspinal ligament should be closed in two or even three separate layers using interrupted-X stitches 0 or 1-0 Vicryl sutures.[3,4,12,14] Alternatively, one could choose to use, stronger, and longer-lasting PDS Polydioxanone sutures (PDS II:) absorbable suture maintain; 25% of tensile strength at 42 days; resorbs 130–180 days).[7] Third, closure of subcutaneous tissues should employ inverted Vicryl 2-0 in two planes for tissues >25 mm in depth.[6] Fourth, skin closure should include the use of simple nylon 3-0 sutures(i.e., others may use a running 2 or 3-0 Monocryl (i.e., 75% glycolide and 25% ε-caprolactone)[9,12,13] [Figure 1 and Table 4].

## CONCLUSION

Process standardization enables evidence-based continual improvement by comparing different interventions on the same process.[11] There is a great variability for the closure of multilevel lumbar fusions performed utilizing a midline posterior approach.

### Declaration of patient consent

Patient's consent not required as there are no patients in this study.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. Buser Z, Chang K, Kall R, Formanek B, Arakelyan A, Pak S, *et al*. Lumbar surgical drains do not increase the risk of infections in patients undergoing spine surgery. Eur Spine J 2022;31:1775-83.
2. Fang Z, Jia Y, Tian R, Liu Y. Subfascial drainage for management of cerebrospinal fluid leakage after posterior spine surgery-a prospective study based on Poiseuille's law. Chin J Traumatol 2016;19:35-8.
3. Haupt S, Cornaz F, Falkowski AL, Widmer J, Farshad M. Biomechanical considerations of the posterior surgical approach to the lumbar spine. Spine J 2022. Doi: 10.1016/j.spinee.2022.08.006.
4. Klinger N, Yilmaz E, Halalmeh DR, Tubbs RS, Moisi MD. Reattachment of the multifidus tendon in lumbar surgery to decrease postoperative back pain: A technical note. Cureus 2019;11:e6366.
5. Lee N, Shin J, Kothari P, Kim J, Leven D, Steinberger J, *et al*. Incidence, impact, and risk factors for 30-day wound complications following elective adult spinal deformity surgery. Global Spine J 2017;7:417-24.
6. Mehta A, Babu R, Karikari I, Grunch B, Agarwal V, Owens T, *et al*. 2012 young investigator award winner: The distribution of body mass as a significant risk factor for lumbar spinal fusion postoperative infections. Spine (Phila Pa 1976) 2012;37:1652-6.
7. Müller DA, Snedeker JG, Meyer DC. Two-month longitudinal study of mechanical properties of absorbable sutures used in orthopedic surgery. J Orthop Surg Res 2016;11:111.
8. Mirzai H, Eminoglu M, Orguc Ş. Are drains useful for lumbar disc surgery? A prospective, randomized clinical study. J Spinal Disord Tech 2006;19:171-7.
9. Shani A, Poliansky V, Mulla H, Rahamimov N. Nylon skin sutures carry a lower risk of post-operative infection than metal staples in open posterior spine surgery: A retrospective case-control study of 270 patients. Surg Infect (Larchmt) 2020;21:440-4.
10. Shi H, Huang ZH, Huang Y, Zhu L, Jiang ZL, Wang YT, *et al*. Which criterion for wound drain removal is better following posterior 1-level or 2-level lumbar fusion with instrumentation: Time driven or output driven? Global Spine

J 2021. Doi: 10.1177/21925682211013770.
11. Skjold-Ødegaard B, Søreide K. Standardization in surgery: Friend or foe? Br J Surg 2020;107:1094-6.
12. Suter A, Spirig J, Fornaciari P, Bachmann E, Götschi T, Klein K, *et al*. Watertightness of wound closure in lumbar spine-a comparison of different techniques. J Spine Surg 2019;5:358-64.
13. Yilmaz E, Blecher R, Moisi M, Ankush C, O'Lynnger T, Abdul-Jabbar A, *et al*. Is there an optimal wound closure technique for major posterior spine surgery? A systematic review. Global Spine J 2018;8:535-44.
14. Yilmaz E, Tawfik T, O'Lynnger T, Iwanaga J, Blecher R, Abdul-Jabbar A, *et al*. Wound closure after posterior multi-level lumbar spine surgery: An anatomical cadaver study and technical note. Cureus 2018;10:e3595.

**How to cite this article:** Montes-Aguilar OJ, Alaniz-Sida KK, Alvarez-Betancourt L, Dufoo-Olvera M, Ladewig-Bernaldez G, López-López R, *et al*. Variability in wound closure technique in midline posterior lumbar fusion surgery. International survey and standardized closure technique proposal. Surg Neurol Int 2022;13:534.