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

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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].

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

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

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. |
| 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. |
| Fang, et al. (2016) | Efficacy subfascial drain with CSF leak (Poiseuille's law) | Drain decreases subfascial space pressure-helps wound healing. |
| 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. |
| MUSCLE, FASCIA, AND SUPRASPINOUS LIGAMENT | Biomechanical cadaveric study. | Suturing fascia to the spinal processes – no improved passive stability but reduces dead space for seroma and faster postoperative rehab. |
| Haupt, et al. (2022) | Biomechanical cadaveric study. | Reapproximation of lumbar multifidus to restore paraspinal anatomical integrity, may lead to improved outcomes, < postop pain, and > patient satisfaction. |
| Huang, et al. (2018) | Technical report. | X stitches suturing (median=180 mbar) resulted in the most watertight closure for fascia closure. |
| Müller, et al. (2016) | 0 Vicryl suture to tightly reapproximate the fascial layer using a simple interrupted technique. | 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. |
| SUBCUTANEOUS TISSUE | Technical note. | Inverted stitches of Vicryl 2-0. |
| Yilmaz, et al. (2018) | 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. |
| Mehta, et al. (2012) | Comparative study of six different suture materials in orthopedic surgery. | 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%). |
| SKIN | Systematic review | No statically significant difference for skin hermetic closure between different suture techniques and PLF. |
| 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. | There is lack of evidence for an optimal wound closure technique in posterior spine surgery. |
| Suter, et al. (2019) | Leakage pressure of different suturing techniques for each layer in a sheep cadaveric model. | There is lack of evidence for an optimal wound closure technique in posterior spine surgery. |
| Yilmaz, et al. (2018) | Systematic review | There is lack of evidence for an optimal wound closure technique in posterior spine surgery. |

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. May use running 2 or 3-0 Monocryl. |
| 4.     | Skin          | Simple stitches of nylon 3-0. |          |

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
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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). 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. 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). Third, closure of subcutaneous tissues should employ inverted Vicryl 2-0 in two planes for tissues >25 mm in depth. 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) [Figure 1 and Table 4].

CONCLUSION

Process standardization enables evidence-based continual improvement by comparing different interventions on the same process. 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.

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Conflicts of interest

There are no conflicts of interest.

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