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Title: Expansion Duroplasty for Severe Cervical Spinal Cord Swelling after Traumatic Injury: A Step-by-Step Surgical Protocol

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Author Questionnaire

1. We have marked your project as author-provided footage, meaning you film the video yourself and provide JoVE with the footage to edit. JoVE will not send the videographer. Please confirm that this is correct.

✓ Correct

2. Interview statements: Which interview statement filming option is the most appropriate for your group? **Please select one.**



Interview Statements are read by JoVE's voiceover talent.

Current Protocol Length

Number of Steps: 17

Number of Shots: 21

Introduction

NOTE to VO producer: Please generate the Vo for interviews

Authors: Please note that **the questions will not appear on screen.** *Please answer in **stand-alone full sentence with sufficient context.***

Answers are slightly edited in accordance with journal guidelines.

INTRODUCTION:

REQUIRED: ~~Summarize your research focus and the main questions it aims to answer.~~

- 1.1. This research is aimed at standardizing the steps of expansion duroplasty for traumatic cervical spinal cord injury with persistent cord swelling.

1.1.1. B-roll: 2.3.2

~~Describe the research contexts or systems in which this protocol can be applied.~~

- 1.2. This approach is useful when posterior decompression may not fully relieve intradural pressure after traumatic cervical spinal cord injury.

1.2.1. B-roll: 3.6.1

CONCLUSION:

~~What does this protocol allow researchers to study or measure?~~

- 1.3 This protocol allows researchers to study persistent cord swelling after bony decompression.

1.3.1. B-roll: 4.5.1

~~Describe the most important consideration or challenge when performing this protocol.~~

- 1.4. The key challenge is preserving the arachnoid membrane during durotomy. This helps reduce CSF leakage and pseudomeningocele formation.

1.4.1. B-roll: 3.13.1

~~How can future studies build on this work? Describe the questions or research directions that can be investigated next.~~

- 1.5. Future studies can compare laminectomy alone with laminectomy plus expansion duroplasty, and clarify which patients benefit the most from dural expansion.

1.1.1. B-roll: 3.3.2

Ethics Title Card

This research has been approved by the Institutional Review Board of the Chang Gung Medical Foundation

Protocol

2. Posterior Cervical Laminectomy and Expansion Duroplasty

Demonstrators: Ying Li and Cheng Li

- 2.1. To begin, position the patient prone on a radiolucent spinal table [1]. Secure the head in a rigid head holder while maintaining neutral cervical alignment to avoid secondary cord compression [2].

2.1.1. LAB MEDIA: IMG_001 00:00-00:05

2.1.2. LAB MEDIA: IMG_001 00:06-00:13

- 2.2. After disinfecting the posterior cervical region, apply sterile draping in the usual fashion [1] and mark the incision line [2].

2.2.1. LAB MEDIA: IMG_002 00:00-00:05

2.2.1. LAB MEDIA: IMG_002 00:10-00:20

- 2.3. Make a midline posterior cervical skin incision centered over the planned decompression levels [1]. Perform subperiosteal dissection of the paraspinal musculature. Expose the laminae and lateral margins of the posterior elements while preserving the facet joint capsules whenever possible [2].

2.3.1. LAB MEDIA: IMG_002 01:15-01:30

2.3.2. LAB MEDIA: IMG_003 01:50-02:00

- 2.4. Review preoperative sagittal T2-weighted magnetic resonance image to define the extent of spinal cord swelling. Decompress one level above and below the segment with maximal T2 hyperintensity [1].

2.4.1. LAB MEDIA: Figure 6A *Video editor: Highlight the region pointed by the arrow*

3. Posterior Cervical Laminectomy with Durotomy and Dural Reconstruction

- 3.1. After exposure of the posterior cervical elements, place retractors to maintain visualization while avoiding excessive soft-tissue traction [1].

3.1.1. LAB MEDIA: IMG_004 04:50-05:00

- 3.2. Under microscopic visualization, thin the laminae as needed and remove them in a controlled cranial-to-caudal sequence using Kerrison rongeurs [1].
 - 3.2.1. LAB MEDIA: IMG_005 01:50-02:00
- 3.3. Now, carefully detach the ligamentum flavum after adequate bony decompression and remove it while avoiding abrupt instrument passage beneath the lamina [1].
 - 3.3.1. LAB MEDIA: IMG_006 00:50-01:00
- 3.4. Keep all instruments tangential to the laminar surface and avoid downward force toward the swollen spinal cord [1].
 - 3.4.1. LAB MEDIA: IMG_006 03:20-03:30
- 3.5. Preserve the facet joints whenever possible to minimize additional destabilization [1].
 - 3.5.1. LAB MEDIA: IMG_007 00:20-00:30
- 3.6. Perform a longitudinal midline durotomy under microscopic visualization using a microsurgical blade. Begin cranially and extend caudally along the decompressed segment [1].
 - 3.6.1. LAB MEDIA: IMG_008 01:55-02:05
- 3.7. Open the dura gradually with a nerve hook oriented parallel to the dural surface while gently elevating the dura to control tension and avoid contact with the swollen spinal cord [1].
 - 3.7.1. LAB MEDIA: IMG_008 05:55-06:00 and 06:30-00:35
- 3.8. Then, extend the durotomy to match the decompressed segment and the visually swollen cord region [1].
 - 3.8.1. LAB MEDIA: IMG_008 23:08-23:13
- 3.9. Selectively divide one or more dentate ligaments on each side as needed at the levels of maximal cord swelling [1]. Judge adequate release by reduction of asymmetric tethering and improved uniformity of cord expansion [2].
 - 3.9.1. LAB MEDIA: IMG_008 23:34-23:40
 - 3.9.2. LAB MEDIA: IMG_008 23:55-24:05
- 3.10. Preserve arachnoid integrity during all steps of dural opening [1].
 - 3.10.1. LAB MEDIA: IMG_008 29:23-29:35
- 3.11. Secure the artificial dural substitute using interrupted 5-0 polypropylene sutures along the dural edges [1].
 - 3.11.1. LAB MEDIA: IMG_009 00:10-00:25

3.12. Next, place sutures at regular intervals with shallow bites to maintain a watertight seal [1].

3.12.1. LAB MEDIA: IMG_009 00:25-00:30 and 01:28-01:33

3.13. Finally, inspect the closure line under the microscope for focal gaping, persistent tension, or visible cerebrospinal fluid leakage, particularly at the superior and inferior junctions [1] and cover the closure site with a waterproof adhesive film dressing [2].

3.13.1. LAB MEDIA: IMG_010 13:30-13:40

3.13.2. LAB MEDIA: IMG_010 13:55-14:00 and 15:50-16:00

Results

4. Results

- 4.1. Representative sagittal T2-weighted magnetic resonance images were obtained from a patient with severe cervical traumatic spinal cord injury who underwent posterior decompression and expansion duroplasty [1].
 - 4.1.1. LAB MEDIA: Figure 6.
- 4.2. Preoperative imaging showed near-complete effacement of the dorsal cerebrospinal fluid space at the level of maximal cord compression [1].
 - 4.2.1. LAB MEDIA: Figure 6A. *Video editor: Highlight the area marked by the white arrowhead where the space behind the spinal cord appears nearly absent.*
- 4.3. Postoperative day 7 imaging demonstrated restoration of the dorsal cerebrospinal fluid space, with maximal thickness measuring approximately 2.2 millimeters [1].
 - 4.3.1. LAB MEDIA: *Figure 6B. Video editor: Highlight the double-headed arrow showing the restored space behind the spinal cord.*
- 4.4. On postoperative day 14, the dorsal cerebrospinal fluid space remained preserved, with maximal thickness measuring approximately 2.6 millimeters [1].
 - 4.4.1. LAB MEDIA: Figure 6C. *Video editor: Highlight the black double-headed arrow marking the thickness of the space behind the spinal cord.*
- 4.5. The longitudinal extent of the restored visible pericord cerebrospinal fluid space measured approximately 18 millimeters [1].
 - 4.5.1. LAB MEDIA: Figure 6C. *Video editor: Highlight the long white double-headed arrow indicating the vertical length of the restored fluid space.*

1. Laminectomy

Pronunciation link: <https://www.merriam-webster.com/dictionary/laminectomy>

IPA: /ˌlæməˈnek.tə.mi/

Phonetic Spelling: lam·uh·nek·tuh·mee

2. Radiolucent

Pronunciation link: <https://www.merriam-webster.com/dictionary/radiolucent>

- IPA: /ˌreɪdi.ooʻluːsənt/
Phonetic Spelling: ray·dee·oh·loo·suhnt
3. Cervical
Pronunciation link: <https://www.merriam-webster.com/dictionary/cervical>
IPA: /ˈsɜːvɪkəl/
Phonetic Spelling: sur·vih·kuhl
 4. Subperiosteal
Pronunciation link: <https://www.merriam-webster.com/dictionary/subperiosteal>
IPA: /ˌsʌbˌperiˈɑːstiəl/
Phonetic Spelling: sub·pair·ee·os·tee·uhl
 5. Paraspinal
Pronunciation link: <https://www.merriam-webster.com/medical/paraspinal>
IPA: /ˌpærəˈspainəl/
Phonetic Spelling: pair·uh·spy·nuhl
 6. Laminae
Pronunciation link: <https://www.merriam-webster.com/dictionary/lamina>
IPA: /ˈlæmɪˌniː/
Phonetic Spelling: lam·ih·nee
 7. Sagittal
Pronunciation link: <https://www.merriam-webster.com/dictionary/sagittal>
IPA: /ˈsædʒɪtəl/
Phonetic Spelling: saj·ih·tuhl
 8. Hyperintensity
Pronunciation link: <https://www.merriam-webster.com/medical/hyperintensity>
IPA: /ˌhaɪpərɪnˈtensəti/
Phonetic Spelling: hy·pur·in·ten·suh·tee
 9. Decompression
Pronunciation link: <https://www.merriam-webster.com/dictionary/decompression>
IPA: /ˌdiːkəmˈpreʃən/
Phonetic Spelling: dee·kum·presh·uhn
 10. Microscopic
Pronunciation link: <https://www.merriam-webster.com/dictionary/microscopic>
IPA: /ˌmaɪkrəˈskɑːpɪk/
Phonetic Spelling: my·kruh·skop·ik
 11. Kerrison
Pronunciation link: <https://www.howtopronounce.com/kerrison>
IPA: /ˈkerɪsən/
Phonetic Spelling: ker·ih·suhn
 12. Ligamentum flavum
Pronunciation link: <https://www.howtopronounce.com/ligamentum-flavum>
IPA: /ˌlɪɡəˈmentəm ˈflɛvəm/
Phonetic Spelling: lig·uh·men·tum flay·vum
 13. Durotomy
Pronunciation link: <https://www.merriam-webster.com/medical/durotomy>

- IPA: /dʊˈrɑ:təmi/
Phonetic Spelling: du·rah·tuh·mee
14. Arachnoid
Pronunciation link: <https://www.merriam-webster.com/dictionary/arachnoid>
IPA: /əˈrækˌnɔɪd/
Phonetic Spelling: uh·rak·noyd
15. Cerebrospinal
Pronunciation link: <https://www.merriam-webster.com/dictionary/cerebrospinal>
IPA: /səˈri:broʊˈspɑnəl/
Phonetic Spelling: suh·ree·broh·spy·nuhl
16. Duroplasty
Pronunciation link: <https://www.howtopronounce.com/duroplasty>
IPA: /ˈdʊroʊˌplæsti/
Phonetic Spelling: dur·oh·plas·tee
17. Pericord
Pronunciation link: No confirmed link found
IPA: /ˌperiˈkɔːrd/
Phonetic Spelling: pair·ee·kord
18. Polypropylene
Pronunciation link: <https://www.merriam-webster.com/dictionary/polypropylene>
IPA: /ˌpɑːliˈproʊpəliːn/
Phonetic Spelling: pol·ee·proh·puh·leen
19. Dentate
Pronunciation link: <https://www.merriam-webster.com/dictionary/dentate>
IPA: /ˈdenˌteɪt/
Phonetic Spelling: den·tayt
20. Musculature
Pronunciation link: <https://www.merriam-webster.com/dictionary/musculature>
IPA: /ˈmʌskjələˌtʃʊr/
Phonetic Spelling: mus·kyuh·luh·chur