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Title: Transforaminal Full-Endoscopic Lumbar Foraminotomy Under Local Anesthesia for L5/S1 Adjacent Segment Foraminal Stenosis

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Author Questionnaire

1. **Microscopy**: Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or something similar? **Yes, all done**

2. **Software:** Does the part of your protocol being filmed include step-by-step descriptions of software usage? **No**

3. **Filming location:** Will the filming need to take place in multiple locations? **No, only in Operation room in Tokushima University**

4. **Testimonials (optional):** Would you be open to filming two short testimonial statements **live during your JoVE shoot**? These will **not appear in your JoVE video** but may be used in JoVE's promotional materials. **Yes**

Current Protocol Length
Number of Steps: 22
Number of Shots: 35 (13 Scope)

Introduction

Videographer: Obtain headshots for all authors available at the filming location.

Videographer's NOTE: The interviews were shot in 4K by mistake. I switched to 1080 from the testimonials.

REQUIRED: What is the scope of your research? What questions are you trying to answer?

1.1. **Koichi Sairyo:** ~~Okay everybody,~~ **in this paper we described adjacent level foramminal stenosis and we treat that problem using the endoscope**. ~~Usually, there are five vertebral bodies, and it's moving on the sacral and after fusion surgery mobile segment got decreased, that will be eighty percent. Then adjacent level gets worse. Then we need another surgery. Basically, gold standard, additional fusion, additional reducing the mobile segment. To keep mobile segment, we need a special decompression surgery. This is endoscopic surgery. The most problematic level is L5-S1.~~

~~For such situation, we use full endoscope. Like the diameter is 8mm, so small. So, we put endoscope in the foraminal area and decompress foramen completely. So, we can keep mobile segment.~~

~~And fusion surgery is impossible under local anesthesia. So recently, in Japanese population, over 85 years old, over 90 years old, patient is suffering from such problem. So local anesthesia. Endoscopic foraminal decompression is very useful to keep mobile segment. Thank you~~.

1.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 2.3.1* **NOTE**: The authors has edited the statement on spot and has spoken a big paragraph. Please take only the 2 lines that are mentioned in bold above and delete the other words/sentences that are struck

What are the most recent developments in your field of research?

1.2. **Koichi Sairyo :** ~~We need to decompress for the stenotic disease. We need to decompress any type of Stenosis. So finally~~, **the most problematic pathology is L5 spondylolisthesis with a structure. That's a very difficult case. So basically, we need fusion. But finally, using the endoscope, we developed the most novel technique, "Criss-cross compression"**. ~~So finally, most of the pathologies need decompression. We can perform it under local anesthesia, endoscopic surgery. The second thing is low back pain. Pain medicine. From low back pain from this, low back pain from type of Modic change. This kind of pathology, we need fusion surgery, basically. But we can use endoscope. We can insert the endoscope into the disc, so we can perform pain management using the endoscope.So please use the endoscope for decompression and pain medicine. Thank you~~.

1.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 2.5.1* **NOTE**: The authors has edited the statement on spot and has spoken a big paragraph. Please take only the 2 lines that are mentioned in bold above and delete the other words/sentences that are struck

What research gap are you addressing with your protocol?

1.3. **Takayuki Kitahara:** For adjacent segment foraminal stenosis at L5/S1, fusion extension was often the only option. Our protocol offers a motion-preserving, reproducible endoscopic alternative.

1.3.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 3.2.1*

Videographer's NOTE: This was filmed first followed by 1.4.1, then 1.1.1 and 1.2.1

What advantage does your protocol offer compared to other techniques?

1.4. **Takayuki Kitahara:** Our protocol enables consistent, reproducible decompression with minimal fluoroscopy and reduced patient burden compared to conventional foraminotomy techniques.

1.4.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 4.2.1*

~~What questions will future research focus on?~~

~~1.5. **Koichi Sairyo:** (We will combine sections 1.1. and1.5.)~~

~~1.5.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 4.4.1*~~

Videographer: Obtain headshots for all authors available at the filming location.

Testimonial Questions (OPTIONAL):

Videographer: Please capture all testimonial shots in a wide-angle format with sufficient headspace, as the final videos will be rendered in a 1:1 aspect ratio. Testimonial statements will be presented live by the authors, sharing their spontaneous perspectives.

How do you think publishing with JoVE will enhance the visibility and impact of your research?

1.6. **Koichi Sairyo, Professor and Chair, Department of Orthopedic Surgery, Tokushima University; President, Tokushima University Hospital**: (authors will present their testimonial statements live)

1.6.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 2.3.1*

Can you share a specific success story or benefit you've experienced—or expect to experience—after using or publishing with JoVE? (This could include increased collaborations, citations, funding opportunities, streamlined lab procedures, reduced training time, cost savings in the lab, or improved lab productivity.)

1.7. **Koichi Sairyo, Professor and Chair, Department of Orthopedic Surgery, Tokushima University; President, Tokushima University Hospital**: (authors will present their testimonial statements live) **NOTE**: This section was combined with 1.6

1.7.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll:4.2.1*

Ethics Title Card

This research has been approved by the Institutional Review Board at the Tokushima University Hospital

Protocol

2. Local Anesthesia and Skin Incision

Demonstrator: Takafumi Ohshima
Videographer's NOTE: No visual slate.

2.1. To begin, establish an intermittent anteroposterior and lateral fluoroscopic view at the desired site **[1]** and advance the 23-gauge needle along the planned trajectory toward the S1 superior articular process **[2]**. Incrementally infiltrate approximately 7 milliliters of 1 percent lidocaine solution into the paraspinal muscles and soft tissues along this pathway **[3]**.

2.1.1. WIDE: Talent positioning the fluoroscopy machine.

2.1.2. Talent advancing the 23 gauge needle under fluoroscopic guidance toward the S1 superior articular process. **Videographer's NOTE:** 2.1.2 - 2.1.3 shot together

2.1.3. Talent injecting lidocaine incrementally into paraspinal muscles and soft tissues, needle in motion under fluoroscopy.

2.2. Then, switch to an 18-gauge, 200-millimeter needle for targeted deep infiltration of anesthesia **[1]**. Under continued intermittent fluoroscopic guidance, advance the needle to the next anatomical targets **[2]**.

2.2.1. Talent swapping the 23 gauge needle for the 18 gauge, 200 millimeter needle.

2.2.2. Talent monitoring the fluoroscopic views.

2.3. Inject 2 milliliters of 1 percent lidocaine into the L5-S1 facet joint capsule **[1]**. Next, inject 2 milliliters into the tip of the S1 superior articular process and 2 milliliters into the middle portion of the S1 superior articular process **[2]**.

2.3.1. Talent positioning the needle tip into the L5/S1 facet joint under fluoroscopy and injecting lidocaine. **Videographer's NOTE:** 2.3.1 to 2.4.1 shot together

2.3.2. Talent targeting the S1 SAP tip, injecting lidocaine, then repositioning to the middle portion and injecting again under fluoroscopy.

2.4. Then, inject 2 milliliters of lidocaine onto the S1 superior endplate, if safely accessible **[1]**.

2.4.1. Talent carefully aiming the needle onto the S1 superior endplate under fluoroscopy and injecting lidocaine.

2.5. Advance the needle tip to the surface of the L5-S1 annulus fibrosus. Confirm satisfactory needle positioning with an AP fluoroscopic view **[1]**. Then, inject approximately 2 milliliters of lidocaine onto the annular surface **[2]**.

2.5.1. Talent advancing the needle to the L5/S1 annulus fibrosus, verifying placement in the AP view. **Videographer's NOTE:** 2.5.1 and 2.5.2 shot together

2.5.2. Talent injecting lidocaine onto the annular surface under fluoroscopy.

2.6. Further advance the needle into the L5-S1 disc space **[1]** and inject an additional 2 milliliters of lidocaine **[2]**.

2.6.1. Talent advancing the needle tip into the L5/S1 disc space under fluoroscopic guidance. **Videographer's NOTE:** 2.6.1 to 2.7.1 shot together

2.6.2. Talent injecting the additional lidocaine into the disc space.

2.7. Now, inject 1 to 2 milliliters of indigo carmine solution into the disc space for staining if disc material identification is anticipated to be critical **[1-TXT]**.

2.7.1. Talent preparing indigo carmine and injecting 1–2 milliliters into the disc space under fluoroscopy. **TXT: Make an 8 mm incision at the fully anesthetized skin entry point**

~~2.8. Make an 8-millimeter incision at the fully anesthetized skin entry point using a number 11 or number 15 scalpel blade, extending through the fascia **[1]**.~~

~~2.8.1. Talent making an 8 millimeter incision through skin and fascia with a #11 or #15 scalpel.~~ **NOTE**: Deleted, VO moved as on screen text

3. Placement of the Working Cannula

3.1. Insert the initial blunt-tipped serial dilator through the 8-millimeter skin incision along the anesthetized trajectory **[1-TXT]**.

3.1.1. Talent introducing the initial blunt-tipped serial dilator through the incision along the anesthetized path. **TXT: Use a guidewire if required** **Videographer's NOTE:** 3.1.1 to 3.3.1 shot together

3.2. Under intermittent AP and lateral C-arm fluoroscopic guidance, sequentially advance

the serial dilators with gentle rotating movements toward the lateral aspect of the S1 superior articular process **[1]**.

3.2.1. Talent advancing serial dilators one by one, rotating gently, under fluoroscopic guidance toward the lateral S1 SAP.

3.3. Confirm that the tip of each dilator is accurately positioned on the bony surface of the S1 superior articular process, ideally at the junction of the SAP and pedicle **[1-TXT]**.

3.3.1. Talent verifying dilator tip placement on bone under fluoroscopy, ensuring contact at the SAP–pedicle junction. **TXT: Ensure the final dilator rests securely on bone**

3.4. Next, advance the beveled working cannula with eight millimeters inner diameter and 165 millimeters length **[1]** over the final dilator until it is firmly docked on the lateral aspect of the S1 superior articular process **[2]**.

3.4.1. Show the cannula. **Videographer's NOTE:** 3.4.1 and 3.4.2 shot together

3.4.2. Talent sliding the beveled working cannula over the final dilator, docking it securely on the lateral S1 SAP under fluoroscopy.

3.5. Confirm the final cannula position using AP and lateral fluoroscopy. On the AP view, dock the cannula on the lateral aspect of the superior articular process **[1]**. On the lateral view, position the cannula tip at the posterior aspect of the foramen, directly overlying the SAP **[2-TXT]**.

3.5.1. Talent checking AP fluoroscopic view to confirm lateral docking on SAP. **Videographer's NOTE:** 3.5.1 to 3.6.1 shot together

3.5.2. Shot of the cannula tip positioned at the posterior aspect of the foramen. **TXT: Ensure the cannula is not inserted too deeply into the foramen or spinal canal**

3.6. Now, carefully remove the final dilator, leaving the working cannula in place as the operative portal **[1]**.

3.6.1. Talent withdrawing the final dilator while ensuring the working cannula remains steadily in place.

4. Foraminoplasty: Resection of the Superior Articular Process (SAP)

Demonstrator: Koichi Sairyo

4.1. With the lateral aspect of the S1 superior articular process clearly visualized, commence the foraminoplasty using a high-speed endoscopic drill **[1 and 2-TXT]**.

4.1.1. Talent operating the drill at the S1 SA process. *Video editor: Please use split screen to show 4.1.1 and 4.1.2 simultaneously*

4.1.2. SCOPE: 69059_2.5-2.8.mp4 00:00 – 00:10 **TXT: Drill: ~65,000 rpm; Equipped with a 3.5 mm diamond-tipped bur**

4.2. Start drilling at the caudal base of the S1 superior articular process, at its junction with the S1 pedicle **[1 and 2]**.

4.2.1. Talent making hand movements to drill at the indented spot. *Video editor: Please use split screen to show 4.2.1 and 4.2.2 simultaneously*

4.2.2. SCOPE: 69059_2.5-2.8.mp4 00:11 – 00:24

4.3. Then, systematically resect the ventral and cranial portions of the S1 superior articular process **[1]**. Drill in a caudal-to-cranial direction, gradually shaving the superior articular process from its base towards its tip **[2]**. Unroof the L5-S1 foramen dorsally and laterally to expose the underlying ligamentum flavum and decompress the exiting L5 nerve root **[3]**.

4.3.1. SCOPE: 69059_2.5-2.8.mp4 00:25 – 00:29

4.3.2. SCOPE: 69059_2.5-2.8.mp4 00:30 – 00:33

4.3.3. SCOPE: 69059_2.5-2.8.mp4 00:33 – 00:36

4.4. Continue drilling until approximately 80 to 90% of the hypertrophied portion of the superior articular process is resected and the foraminal ligamentum flavum and the shoulder of the L5 exiting nerve root are sufficiently exposed **[1-TXT]**.

4.4.1. SCOPE: 69059_2.5-2.8.mp4 00:37 – 00:48 **TXT: Use preoperative CT scans and the intraoperative endoscopic view for guidance**

4.5. Using the high-speed endoscopic drill, carefully resect a portion of the ventral aspect of the L5 inferior articular process **[1]**.

4.5.1. SCOPE: 69059_2.5-2.8.mp4 00:49 – 01:01

4.6. To perform the detach technique, press the cranial half of a spherical bur tip against the bony edge of the S1 superior articular process at the ligament's insertion point **[1 and 2]**. Employ a rotational shaving motion to resect this bone, while simultaneously pulling the drill proximally to direct the resection away from the thecal sac and safely release the ligamentum flavum **[3 and 4]**.

4.6.1. Talent press the cranial half of a spherical bur tip against the bony edge of the S1 superior articular process. *Video editor: Please use split screen to show 4.6.1 and 4.6.2 simultaneously*

4.6.2. SCOPE: 69059_2.5-2.8.mp4 01:02 – 01:17

4.6.3. Talent employing a rotational shaving motion to resect this bone, while simultaneously pulling the drill proximally to direct the resection. *Video editor: Please use split screen to show 4.6.3 and 4.6.4 simultaneously* **Videographer's NOTE:** Use take 2

4.6.4. SCOPE: 69059_2.5-2.8.mp4 01:17 – 01:32

4.7. Observe the detached ligamentum flavum for pulsation **[1]**.

4.7.1. SCOPE: 69059_2.5-2.8.mp4 01:38 – 01:52

4.8. Finally, grasp the free-floating, detached ligamentum flavum with a 3.5-millimeter Kerrison punch or endoscopic rongeurs **[1 and 2]**. Carefully remove the ligament from the foramen **[3]** and observe the decompressed nerve root **[4]**.

4.8.1. Talent grasping the free-floating, detached ligamentum flavum with a 3.5-millimeter Kerrison punch. *Video editor: Please use split screen to show 4.8.1 and 4.8.2 simultaneously*

4.8.2. SCOPE: 69059_2.5-2.8.mp4 01:55 – 02:02

4.8.3. SCOPE: 69059_2.5-2.8.mp4 02:02 – 02:09

4.8.4. SCOPE: 69059_2.5-2.8.mp4 02:09 – 02:22

Results

5. Results

5.1. Preoperative magnetic resonance imaging confirmed right-sided L5-S1 foraminal stenosis with compression of the exiting L5 nerve root due to a herniated nucleus pulposus **[1]**.

5.1.1. LAB MEDIA: Figure 7.

5.2. Preoperative computed tomography scans showed severe foraminal narrowing at L5-S1 caused by a hypertrophied superior articular process **[1]**.

5.2.1. LAB MEDIA: Figure 8. *Video editor: Highlight the yellow arrows and dotted outline on the two left-side "Before surgery" CT images*.

5.3. Postoperative computed tomography images demonstrated successful decompression, with resection of the ventral-cranial portion of the superior articular process and visible enlargement of the L5-S1 foramen **[1]**.

5.3.1. LAB MEDIA: Figure 8. *Video editor: Highlight the white arrow and dotted outline on the two right-side "After surgery" CT images*.

1. Paraspinal
Pronunciation link: https://www.merriam-webster.com/dictionary/paraspinal
IPA: /ˌpær.əˈspaɪ.nəl/
Phonetic Spelling: par-uh-spy-nuhl

2. Anteroposterior
Pronunciation link: https://www.merriam-webster.com/dictionary/anteroposterior
IPA: /ˌæn.tə.rəʊˈpɒs.tər.i.ər/ (in American, /ˌæn.tə.rəʊˈpɑːstər.iər/)
Phonetic Spelling: an-tuh-roh-pos-teer-ee-er

3. Fluoroscopic
Pronunciation link: https://www.merriam-webster.com/dictionary/fluoroscopic
IPA: /ˌflʊə.rəˈskɒp.ɪk/ (American: /ˌflʊə.rəˈskɑː.pɪk/)
Phonetic Spelling: floo-ruh-skop-ik

4. Trajectory
Pronunciation link: https://www.merriam-webster.com/dictionary/trajectory
IPA: /trəˈdʒɛk.tə.ri/
Phonetic Spelling: truh-jek-tuh-ree

5. Superior (as in "superior articular process")
Pronunciation link: https://www.merriam-webster.com/dictionary/superior
IPA: /suˈpɪr.i.ər/
Phonetic Spelling: soo-peer-ee-er

6. Articular
Pronunciation link: https://www.merriam-webster.com/dictionary/articular
IPA: /ɑrˈtɪk.jə.lər/ (or in American: /ɑrˈtɪk.jə.lər/)
Phonetic Spelling: ar-tik-yuh-ler

7. Cannula
Pronunciation link: https://www.merriam-webster.com/dictionary/cannula
IPA: /ˈkæn.jə.lə/
Phonetic Spelling: kan-yuh-luh

8. Foraminoplasty
(This is a relatively specialized surgical term; no entry in Merriam-Webster, but usage is consistent with "foramen + -plasty")
Pronunciation link: No confirmed link found
IPA: /fɔːˌreɪ.nəˈplæs.ti/ (American: /fɔr.əˌmeɪ.nəˈplæs.ti/)
Phonetic Spelling: for-uh-mee-nuh-plas-tee

9. Hypertrophied
Pronunciation link: https://www.merriam-webster.com/dictionary/hypertrophied
IPA: /ˌhaɪ.pərˈtroʊ·fid/
Phonetic Spelling: hy-per-troh-feed

10. Ligamentum (as in "ligamentum flavum")
Pronunciation link: https://www.merriam-webster.com/dictionary/ligamentum
IPA: /ˌlɪgəˈmɛn.təm/
Phonetic Spelling: lig-uh-men-tum

11. Flamum (in "flavum")
"Flavum" is Latin; usage "ligamentum flavum."
Pronunciation link: No confirmed link found
IPA: /ˈfleɪ.vəm/
Phonetic Spelling: flay-vum